ISSN 0377-9335

ENTOMON

Vol. 38 December 2013 No. 4

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ASSOCIATION FOR ADVANCEMENT OF ENTOMOLOGY
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Association for Advancement of Entomology

(Reg. No. 146/ 1975)
Department of Entomology, Kerala Agricultural University
Vellayani PO, Thiruvanathapuram 695522, Kerala, INDIA

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The newly elected members of Executive Body of Association for Advancement of Entomology (AAE) took charge during February 2014. There was a set back in the AAE activities and publication of ENTOMON due to organisational and administrative problems at its head quarters in University of Kerala, Kariavattam, Trivandrum. The new office bearers of AAE could shift its head quarters with effect from 28 February 2014, to the Department of Entomology, College of Agriculture, Kerala Agricultural University (KAU), Vellayani, Trivandrum 695522, where more than 20 life members of AAE are working in various capacities. With sincere efforts of these members in the KAU, the new Executive Body could establish the office of AAE and set right all the administrative problems in running the various activities of AAE and the publication of ENTOMON.

AAE places on record its gratitude to the KAU authorities for the kind permission to function AAE and ENTOMON in the Department of Entomology, College of Agriculture, KAU, Vellayani, Trivandrum 695522.

With in a period of 10 months ENTOMON volume 37 (2012) as combined issue and 38 (2013) with 4 issues were brought out and the volume 39 (2014) is being processed for publication by March 2015. The earlier recognition and prestige enjoyed by the AAE and its journal ENTOMON will be fully resurrected in 2015. Full cooperation and involvement of every member of AAE is earnestly requested to achieve the above target.

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ENTOMON 38(4): 183 - 192 (2013)
Article No. ent.38401

Morphology of two Indian species of the genus *Rhyparothesus* Scudder (Hemiptera: Rhyparochromidae)

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[2]*Department of Zoology and Environmental Sciences, Punjabi University, Patiala - 147 002, India. E mail: devinder.ss.61@gmail.com*

ABSTRACT: Morphology including genitalia of two Indian species of genus *Rhyparothesus* Scudder i.e. *kangricus* (Kirkaldy) and *dudgeoni* (Distant) has been studied in detail. Photographs of all the structures have been given which were not available so far.

Key words: External genitalia, India, *Rhyparothesus*

INTRODUCTION

The genus *Rhyparothesus* was proposed by Scudder (1962) with *Aphanus orientalis* Distant as its type species. Later on some more species from the Oriental region were brought in its lap by Scudder (1967). The two species being studied here have been collected from North India and their genitalia are being illustrated for the first time. Both the species have been found under leaf litter on ground along with several other species of this family. For desrcibing the external male and female genitalia terminology used by Ashlock (1957) and Scudder (1959) has been followed.

This genus is diagnosed by the following combination of characters: head more or less impunctate; anterior half of pronotal disc punctuate; clavus densely and irregularly punctuate; apical third of corium distinctly punctuate, the punctures present along apical margin; clypeus not greatly exceeding apex of paraclypeal lobes; whole of dorsum pale; except head, anterior part of pronotal disc and base of scutellum dark- brown black.

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MATERIALS AND METHOD

Bugs were collected with the help of insect net from leaf litter and by beating vegetation and branches of trees below which a white sheet was spread. After collection the bugs were killed with ethyl acetate vapours and pinned, stretched and kept in wooden boxes for further examination. For dissection of male and female genitalia the dried specimens were relaxed by keeping them in a pertidish under wet conditions for few hours. Their abdomens were separated from the whole insect and were kept in 10% KOH at 70° temperature for 40-80 minutes depending upon the size of the insect. After dissections, the structures were washed in distilled water and then dehydrated through ascending grades of alcohol, cleared in clove oil and preserved in glycerin for further studies. Photography was done using image processing unit located in the Department of Zoology and Environmental Sciences, Punjabi University, Patiala. Orientation of the genital structures was arranged in such a way that it clearly depicted its distinctive features. All the measurements have been made under stereozoom binocular microscope fitted with a graph eye piece (ocular grid).

RESULTS AND DISCUSSION

***Rhyparothesus kangricus* (Kirkaldy)**

(Figs. 1- 11)

Aphanus kangricus, Kirkaldy 1907, *Canad. Ent.*, **34:** p. 331.

Rhyparothesus kangricus: Scudder 1967 *Bull. Br. Mus. (Nat. Hist.)Entomol.*, **20(6):** 251-285.

MALE:

Dorsal coloration: (Fig. 1) Head yellowish brown, lateral margins yellowish brown, central two layers dark brown forming a spindle shape structure on clypeus; antennal segments I- IV yellowish brown, apices of segments II and III black, antennae pubescent; eyes dark brown; ocelli brown; pronotum pale yellow with dark brown punctures, anterior portion bright yellow, carina pale yellow; scutellum dark yellow with dark brown punctures; clavus and corium pale yellow with dark brown punctures, fascia near apical edges and posterior edge of corium; connexiva brown; hemelytral membrane brassy color with basal region dark brown.

Ventral coloration: Venter of head dark brown; rostral segments yellowish brown; prosternum dark yellow with dark brown punctures, mesosternum and metasternum brown with dark brown punctures, central area of mesosternum and metasternum dark bown; anterior and posterior lobes of metathoracic peritreme brown; abdominal sternites brown; connexiva brown; genital capsule dark brown.

Legs: Legs yellow with dark brown punctures.

Structure:

Head (Fig. 2): Head broad at base, narrow at tip, wider than long, clypeus longer than paraclypei, clypeus protruding anteriad, clypeus and paraclypei fused, length of anteocular region same that of remainder of head; antenniferous tubercles widely separated; antennal segment I short and stout, extending beyond apex of head, segments II and III slender, cylindrical, segment IV fusiform, antennal formula I< III< IV< II; buccula short, not extending beyond antenniferous tubercles; rostrum short, reaching up to procoxae, rostral formula IV< III< I< II.

Thorax: Pronotum (Fig. 3) with carina, wider than long, anterior angles round, anterior margin substraight, lateral margins obliquely round, humeral angles not prominent, posterior margin sinuate; scutellum triangular, wider than long; corium with costal margin anteriorly substright, posteriorly round; ostiolar peritreme (Fig. 4) broad, reaching more than halfway toward lateral side and near posterior side, anteriorly prominent and posteriorly subprominent.

Abdomen: Hemelytral membrane reaching above last abdominal segment; lateral margins of connexiva round; margins of lateral sides sinuate; ventroposterior margin of abdominal sternite VIII concave (Fig. 5).

Legs: Femora of proleg much thickened, femora of mesoleg and metaleg less dilated, tibiae and tarsi slender, cylindrical, a long thick spine on femora of proleg, hair on tibiae of each leg.

Male genitalia: Pygophore (Figs. 9) spherical with anterior margin straight, outer lateral margin substaright anteriorly broad and posteriorly narrow, posterior margin with median notch, short hair on posterior region, in lateral view anterior margin subround; paramere (Fig. 10) with stem squarish, inner projection squarish with substraight apex, outer projection triangular, broader than inner projection, hair on outer projections, blade long and curved, tapering with subround apex, inner and outer margins round; aedeagus (Fig. 11) with phallosoma broad, conjunctiva without any lobe, ejaculatory reservoir complete, attached to squarish body, wings squarish, a pair of holding sclerites present, vesica broad, gonoporal process long and broad with many coils.

Measurements (in mm): Head length: 0.97; width across eyes: 1.15; length of anteocular region: 0.47; length of remainder head: 0.50; interocular space: 0.70; interocellar space: 0.45; length of antennal segments I: 0.50, II: 1.10, III: 0.70, IV: 1.00; length of labial segments I: 0.65, II: 0.80, III: 0.62, IV: 0.35; pronotum length: 2.10, width at posterior margin: 2.25; scutellar length: 1.30; width: 1.50; length base scutellum to apex clavus: 2.10; claval commissure: 0.75; length of corium: 3.50; length of hemelytra: 4.75; width of membrane: 1.75; length apex scutellum to apex abdomen including membrane: 3.30; maximum width of abdomen: 2.30; total body length: 7.30.

FEMALE:

Coloration: Coloration similar to male except connexival segments VIII and IX black; genital plate black.

Structure: Abdominal sternite VII medially divided, ventroanterior margin of abdominal sternite VII forming inverted V shape structure (Fig. 6).

Female genitalia: (Fig. 7) 1st gonocoxa elongate and triangular, 1st gonapophysis narrow with subacute apex, 8th paratergite almost squarish with outer and inner margins sinuate, 9th paratergite squarish with round lateral margins; (Fig. 8) spermathecal bulb long, tubular with outer margin round, median apical projection round and much broad, duct highly coiled divided in to three parts first part narrow and long, 2nd part spring like, third part with straight tube.

Measurements (in mm): Head length: 1.00; width across eyes: 1.20; length of anteocular region: 0.42; length of remainder head: 0.58; interocular space: 0.75; interocellar space: 0.50; length of antennal segments I: 0.40, II: 1.00, III: 0.80, IV: 1.00; length of labial segments I: 0.65, II: 0.75, III: 0.55, IV: 0.40; pronotum length: 1.80, width at posterior margin: 2.25; scutellar length: 1.55; width: 1.45; length base scutellum to apex clavus: 2.00; claval commissure: 1.10; length of corium: 3.00; length of hemelytra: 4.00; width of membrane: 1.75; length apex scutellum to apex abdomen including membrane: 3.40; maximum width of abdomen: 2.10; total body length: 6.80.

Morphological variations: Head reddish brown; posterior of pronotum covered with punctures light brown; color of clavus and corium black; eyes red; abdominal sternites black; size of male varies from 6.90 to 8.00 mm; size of female varies from 6.50 to 8.00 mm.

Material examined: Punjab: Pathankot, 21.X.2009- 1♂&1♀. Uttarakhand: Dehradun, 23-25.VI.2010- 11♂♂ 5♀♀. Himachal Pradesh: Bilaspur, 21.X.2010- 1♂ 2♀♀

Distribution: India: Himachal Pradesh and Uttarakhand.

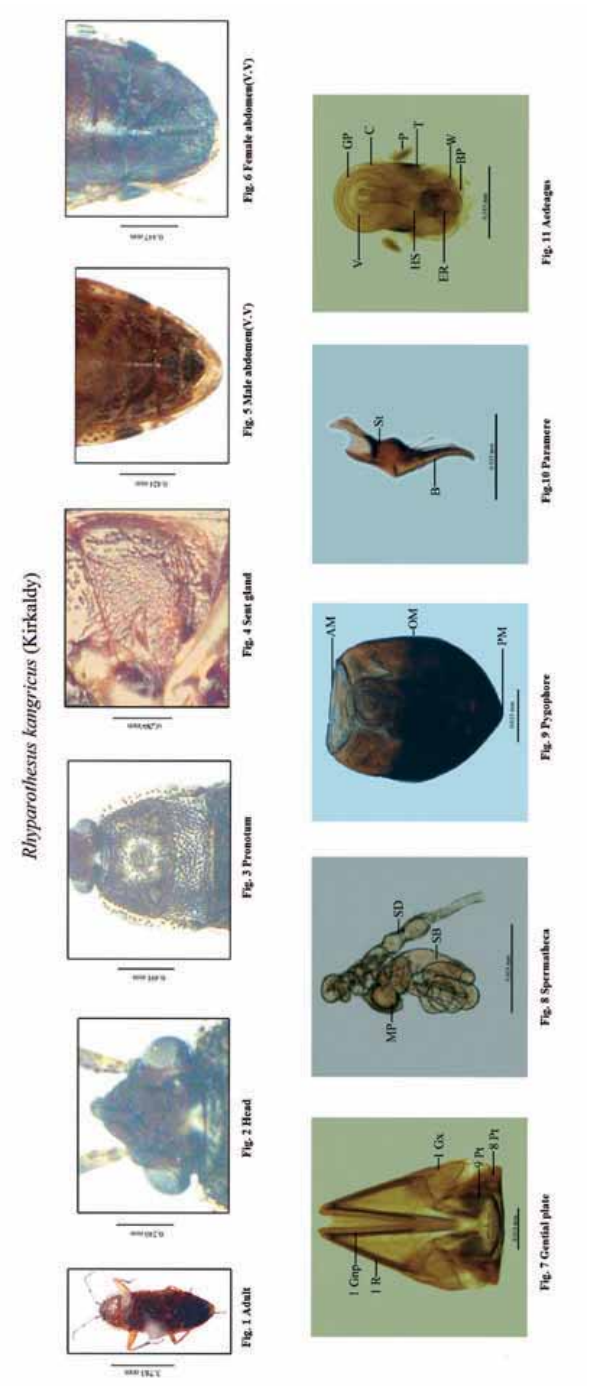
Remarks: This species is found in abundance on ground vegetation under leaf litter along with other species. It is a seed eater bug and is very similar with *R. dudgeoni* but differs in the shape of pronotum. It was proposed in the genus *Aphanus* by Kirkaldy, but later on shifted by Scudder.

Rhyparothesus dudgeoni **(Distant)**

(Figs. 12-22)

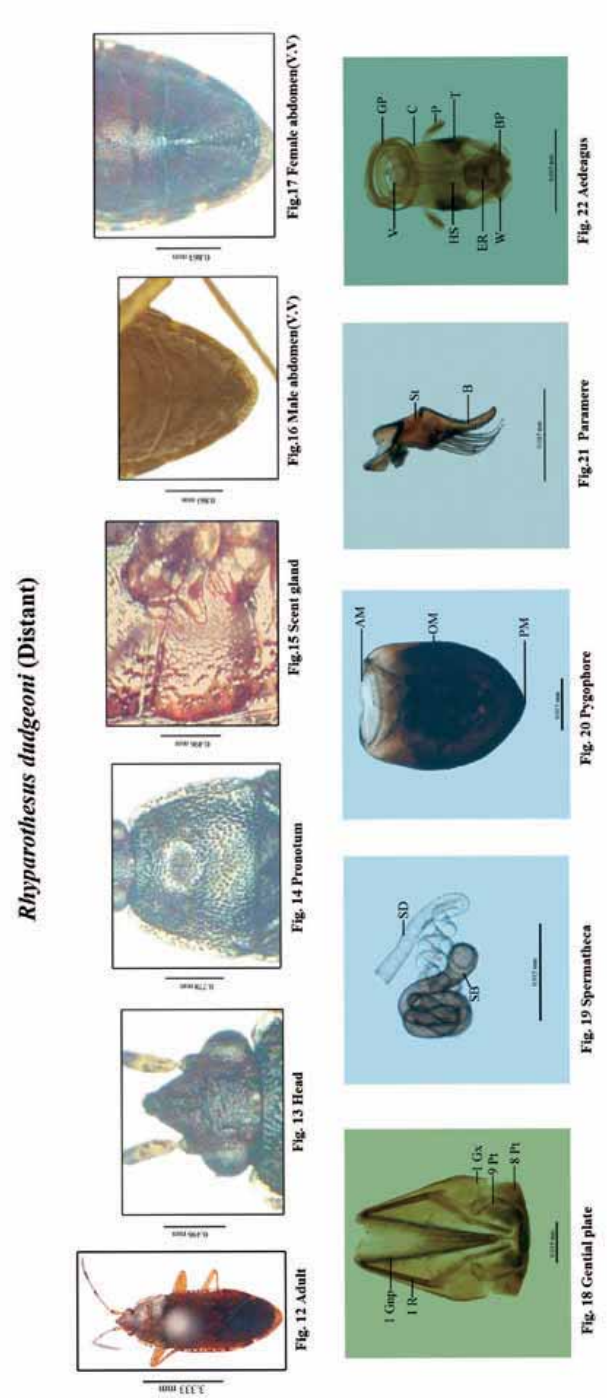
Aphanus dudgeoni, Distant 1909, *Ann. Mag. Nat. Hist.*, **8**(3):491-507.

Rhyparothesus dudgeoni: Scudder 1967 *Bull. Br. Mus. (Nat. Hist.)Entomol.*, 20(6): 251-285.



Figures: *Rhyparothesus kangricus* (Kirkaldy)

(Adult- 1, Head- 2, Pronotum- 3, Scent gland- 4, Male abdomen (V.V.)- 5, Female abdomen (V.V.)-6, Genital plate-7, spermatheca- 8, Pygophore- 9, Paramere- 10, Aedeagus- 11).



Figures: ***Rhyparothesus dudgeoni*** **(Distant)**

(Adult- 12, Head- 13, Pronotum- 14, Scent gland- 15, Male abdomen (V.V.)- 16, Female abdomen (V.V.)- 17, Genital plate-18, spermatheca- 19, Pygophore- 20, Paramere- 21, Aedeagus- 22).

MALE:

Dorsal coloration: (Fig. 12) Head reddish brown with black lines, dark brown central two layers forming a spindle shape structure on clypeus; antennal segment I yellowish brown, segments II and III yellowish brown with apices black, segment IV black with base brown, antennae pubescent; eyes dark brown; ocelli brown; pronotum pale yellow with dark brown punctures, lateral margins with large brown punctures; scutellum yellow with dark brown punctures; hemelytral membrane black.

Ventral coloration: Venter of head dark brown; rostral segments yellowish brown; prosternum dark yellow with dark brown punctures, mesosternum and metasternum brown with dark brown punctures, central area of mesosternum and metasternum dark brown; anterior and posterior lobes of metathoracic peritreme brown; abdominal sternites brown; connexiva brown; genital capsule black with pubescence.

Legs: Legs dark yellow.

Structure:

Head (Fig. 13): Head broad at base, narrow at tip, wider than long, clypeus longer than paraclypei, clypeus protruding anteriad, clypeus and paraclypei fused, length of anteocular region same that of remainder of head; antenniferous tubercles widely separated; antennal segment I short and stout, extending beyond apex of head, segments II and III slender, cylindrical, segment IV fusiform, antennal formula I< III< IV< II; buccula short, not extending beyond antenniferous tubercles; rostrum short, crossing procoxae, rostral formula IV< III< I< II.

Thorax: Pronotum (Fig. 14) with carina, wider than long, anterior angles subacute, anterior margin substraight, lateral margins little round, humeral angles not prominent, posterior margin sinuate; scutellum triangular, as long as wide; corium with costal margin anteriorly substright, posteriorly round; ostiolar peritreme (Fig. 15) triangular, producing posteriorly; evaporative area reaching more than halfway toward lateral side, not reaching to posterior side, anteriorly prominent and posteriorly round.

Abdomen: Hemelytral membrane reaching above last abdominal segment; lateral margins of connexiva rounded; margins of lateral sides of sternum sinuate; ventroposterior margin of abdominal sternite VII concave (Fig. 16).

Legs: Femora of proleg much thickened with a long thick spine, femora of mesoleg and metaleg less dilated, tibiae and tarsi slender, cylindrical, hair on tibiae of each leg.

Male genitalia: Pygophore (Figs. 20) spherical with anterior margin substraight, outer lateral margin substaright, anteriorly broad and posteriorly narrow, posterior margin roundwith medially narrow apex, short hair on posterior region, in lateral view anterior margin subround;

paramere (Fig. 21) with stem squarish, inner projection triangular with substraight apex, outer projection triangular, narrower than inner projection, long hair on outer projections, blade long and curved tapering with subround apex, inner and outer margins round; aedeagus (Fig. 22) with phallosoma broad, conjunctiva without any lobe, ejaculatory reservoir complete, attached to squarish body, wings squarish, a pair of holding sclerites present, vesica broad, gonoporal process long and broad with many coils.

Measurements (in mm): Head length: 1.00; width across eyes: 1.25; length of anteocular region: 0.50; length of remainder head: 0.50; interocular space: 0.70; interocellar space: 0.50; length of antennal segments I: 0.475, II: 1.07, III: 0.90, IV: 1.00; length of labial segments I: 0.75, II: 0.85, III: 0.60, IV: 0.35; pronotum length: 1.75, width at posterior margin: 2.25; scutellar length: 1.40; width: 1.40; length base scutellum to apex clavus: 2.12; claval commissure: 0.60; length of corium: 3.40; length of hemelytra: 4.75; width of membrane: 1.85; length apex scutellum to apex abdomen including membrane: 3.25; maximum width of abdomen: 2.30; total body length: 6.60.

FEMALE:

Coloration: Coloration similar to male except connexival segments VIII and IX black; genital plate black.

Structure: Abdominal sternite VII medially divided, ventroanterior margin of abdominal sternite VII forming inverted V shape structure (Fig. 17).

Female genitalia: (Fig. 18) 1st gonocoxa elongate and triangular, 1st gonapophysis narrow with subacute apex, 8th paratergite almost squarish with outer and inner margins sinuate, 9th paratergite squarish with round lateral margins; (Fig. 19) spermathecal bulb short and round with outer margin round, median apical projection round, duct highly coiled divided in to three parts 1st part narrow and long, 2nd part spring like, 3rd part with straight tube.

Measurements (in mm): Head length: 1.10; width across eyes: 1.25; length of anteocular region: 0.50; length of remainder head: 0.50; interocular space: 0.75; interocellar space: 0.50; length of antennal segments I: 0.475, II: 1.00, III: 0.95, IV: 1.25; length of labial segments I: 0.75, II: 0.85, III: 0.60, IV: 0.35; pronotum length: 1.80, width at posterior margin: 2.50; scutellar length: 1.50; width: 1.50; length base scutellum to apex clavus: 2.10; claval commissure: 0.75; length of corium: 3.85; length of hemelytra: 5.00; width of membrane: 1.75; length apex scutellum to apex abdomen including membrane: 3.50; maximum width of abdomen: 2.60; total body length: 7.00.

Morphological variations: Head black; antennae black; punctures more numerous; abdominal sternites dark brown; legs light yellow; apex of tarsi black; size of male varies from 6.60 mm-8.00 mm and female varies from 6.50 mm- 7.00 mm.

Material examined: Uttarakhand: Dehradun, 23-25.VI.2010- 24♀♀5♂♂.

Distrbution: India: Himachal Pradesh and Uttarakhand.

Remarks: This species is found in abundance from ground vegetation under leaf litter. It is a seed eater bug and is very similar to *kangricus* but differs in the shape of pronotum. It was proposed in the genus *Aphanus* by Kirkaldy, but later on shifted by Scudder. One new locality i.e. Uttarakhand has been added as earlier it was reported from Himachal Pradesh only.

List of abbreviations used

AM: Anterior Margin, B: Blade, BP: Basal Plate, C: Conjunctiva, ER: Ejaculatory Reservoir, Fig.: Figure, Gnp: Gonapophysis, GP: Gonoporal Process, Gx: Gonocoxa, HS: Holding Sclerite, mm: Millimeters, MP: Median Projection, OM: Outer Margin, P: Pivot, PM: Posterior Margin, Pt: Paratergite, R: Ramus, SB: Spermathecal Bulb, SD: Spermathecal Duct, St: Stem, T: Theca, V: Vesica, W: Wing.

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(Received 03-06-2014; accepted 05- 10- 2014)

ENTOMON 38(4): 193 - 212 (2013)
Article No. ent.38402

Review of the grass feeding leafhopper genus *Gurawa* Distant (Hemiptera: Cicadellidae: Deltocephalinae) from the Indian subcontinent with description of two new species

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[2] *Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka*

ABSTRACT: Three species of *Gurawa*, *G. intermediata* Pruthi, *G. minorcephala* Pruthi and *G. vexillum* Distant are redescribed and illustrated. Two new species of *Gurawa* with constricted head in front of eyes, *G. ceylonica* sp. nov. (Sri Lanka: Peradeniya) and *Gurawa constricta* sp. nov. (INDIA: Karnataka) are described and illustrated. A key to known species of *Gurawa* from the subcontinent is also provided.

Key words: *Gurawa*, new species, Chiasmini, India, Sri Lanka.

INTRODUCTION

Distant (1908) established the genus *Gurawa* with *G. vexillum* Distant from Sikkim as the type species. Pruthi (1930, 1936) added two new species, *G. minorcephala* and *G. intermediata*, respectively, in addition to redescribing *G. vexillum* in 1934 (Pruthi 1934). Jacobi (1941) described the fourth species, *G. albofasciata* from Flores (Indonesia). Earlier the genus was placed in the tribe Aphrodini of the subfamily Aphrodinae (Metcalf 1963, Oman *et al*. 1990). Zahniser (2008) redefined the tribe Chiasmini and placed the genus *Gurawa* in that tribe based on the sculpturing of the female valvulae, though the aedeagus lacks the basal articulation found in other genera of the tribe. Duan & Zhang (2012) reviewed the genus from China and in addition to recording *G. minorcephala* from China described the fifth species of the genus *G. truncata* Duan & Zhang.

* Author for correspondence

The species of the genus *Gurawa* are rare and are found on grasses mixed with herbs in India. They can readily be recognized by the foliaceous, triangular head that is usually longer than median length of pronotum, ocelli marginal, placed half way between eye and midlength of crown, forewings thickened with raised veins and hind wings often very much reduced. In this paper three known species from the Indian subcontinent and two new species one each from India and Sri Lanka are described and illustrated. The new species are peculiar in the sense they have the head constricted beyond eyes at level of ocelli, reminiscent of *Listrophora* Boulard (Ulopinae).

The following are the institutions and their abbreviations used in the text where the material studied will be deposited as indicated under each species.

BMNH - The Natural History Museum, London, United Kingdom.

NPC - National Pusa Collection, Indian Agricultural Research Institute, New Delhi, India.

UASB - University of Agricultural Sciences, Bangalore, India.

ZSI - Zoological Survey of India, Kolkata, India.

TAXONOMY

Checklist of *Gurawa* of the Indian subcontinent

Gurawa Distant 1908: 263.

ceylonica sp. nov.	Sri Lanka.
constricta sp. nov.	India (Karnataka).
intermediata Pruthi1936: 107-108, text fig. 121, plate VIII, figs. 7, 7a.	India (Jammu & Kashmir, West Bengal, Sikkim, Meghalaya).
minorcephala Pruthi1930: 29-30.Text figs. 41-42, plate II, figs. 10,10a, 10b.	India (West Bengal, Karnataka, Tamil Nadu, Kerala). Pakistan. China.
vexillum Distant 1908: 263, fig. 169	India (Himachal Pradesh, West Bengal, Meghalaya).

Genus *Gurawa* Distant

[Modified from Pruthi 1930, 1934 and Dun & Zhang 2012]

Gurawa Distant 1908: 263; Pruthi 1930: 29, 1934: 78; Rao 1990: 22-23; Zahniser 2008: 22; Duan & Zhang 2013: 41-44. Type species: *Gurawa vexillum* Distant, by original designation.

Small (3.5-4.2 mm long), brown leafhoppers with or without reddish brown to dark brown markings. Head wider than pronotum, crown medially either as long or longer than distance between eyes, surface wrinkled (in some species granulose) laterally; anteriorly subacute, foliaceous, often raised, lateral margins distinct and thin, either constricted at level with location of ocelli or entire. Ocelli on lateral margins of vertex about midway between eye and apex of crown. Face longer than broad, frontoclypeus long, with shallow depression in upper part, clypellus parallel sided, distally bilobed. Lora narrow, not reaching apex of genae. Genae expanded, exceeding clypellus, deeply concavely excavated below eyes. Labium short reaching front coxae. Pronotum flat, either twice or more as broad as medially long, often with median and sublateral ridges, lateral margins carinate. Scutum and scutellum together as long as or longer than median length of pronotum. Forewings coriaceous, longer than body, 2.5 to 3.5 times as long as wide at broadest region, venation prominent, raised, appendix wanting. Hind wings reduced often scale-like. Profemur setal row AV with 13-15 peg-like setae, m1 present. Protibia rounded in cross section with dorsal macrosetal formula 1+1(AD+PD). Hind femoral setal formula either 2+0 or 2+1, hind tibiae with row AD setae 6±1, AV setae 7±1 and PD setae 8±1, apical transverse row with four to five cucullate setae of which median two to three with platellae-like. Apical transverse row of hind basitarsus with four platellae.

Male: Pygofer without macrosetae, basolateral cleft absent, constricted at about basal 0.33. Valve triangular with acutely rounded posterior angle. Subgenital plates small, rather triangular, without macrosetae. Style broad basally, with rather parallel sided middle portion, subapical lobe well-developed, apophysis of style slightly curved laterally, with one prominent tooth on ventral margin and often with series of smaller teeth more distally. Connective with arms about as long as or slightly longer than stem. Aedeagus with well developed dorsal apodeme, shaft curved, laminately expanded laterally in distal third with dentate lateral margins and with prominent lateroapical spine, gonopore subapical.

Female: Seventh sternite as broad or broader than long, posteriorly produced, posterior margin with median concavity. Pygofer devoid of macrosetae. Ovipositor protruding from pygofer. First pair of valvula with rami almost straight, dorsal sculpturing maculose to granulose, not attaining dorsal margin. Second valvula abruptly broadening in distal half with obliquely triangular teeth.

Remarks: Zahniser (2008), while transferring the genus *Gurawa* to the tribe Chiasmini, discussed its relationship with other chiasmine genera. The genus would appear to be related to *Baileyus* Pruthi judging from the original description of the latter. It can be distinguished from *Baileyus* by the structure of the pygofer which is not constricted at its midlength (see Pruthi, 1930: 32, fig.44A) and by the more deeply bifid shaft of the aedeagus in lateral view (see Pruthi, 1930: 32, fig.44B). Confirmation of the identity of *Baileyus* has not been possible as the male genitalia slides of its type species could not be found in ZSI.

Two new species described below differ from the typical *Gurawa* in the following features (characters of *Gurawa* in parenthesis): a) head constricted at level of placement of ocelli (not so constricted); b) crown of vertex with sublateral ridges (without such ridges); c) frons with short keel in the basal foveae (without such keel in the basal fovea); d) pronotum with median and sublateral ridges (pronotum without prominent ridges, sometimes with weak median carina); e) apophysis of style with one prominent tooth on ventral margin (apophysis of style in addition to one prominent tooth, 4-8 smaller teeth distally). Therefore, these species are only provisionally placed in *Gurawa* pending more detailed study on the genus *Baileyus* pending collection of fresh material.

KEY TO INDIAN SPECIES OF *GURAWA* DISTANT

1. Head constricted at level of ocelli in dorsal view (Fig. 43, 45, 47, 49) 2

- Head not constricted at level of ocelli (Figs. 51, 55) 3

2. Lateral margins of crown beyond constriction diverging (Figs. 43, 45) (Sri Lanka) .....*G. ceylonica* sp. nov.

- Lateral margins of crown beyond constriction parallel sided, not diverging (Figs. 47, 49) (India: Karnataka) .....*G. constricta* sp. nov.

3. Lateroapical spines on apex of aedeagal shaft wide apart, almost parallel to each other (Fig. 27); apophysis of style with 4-5 teeth on ventral margin (Fig. 26)..... .....*G. minorcephala* Pruthi

- Lateroapical spines on apex of aedeagal shaft close together convergent (Fig. 20) or overlapping (Fig. 37); apophysis of style with 7-8 teeth on ventral margin (Figs 21, 33) 4

4. Apices of lateroapical spines of aedeagus overlapping in posterodorsal view (Fig. 37 .....*G. vexillum* Distant

- Apices of lateroapical spines of aedeagus not overlapping in posterodorsal view (Fig. 20 .....*G. intermediata* Pruthi

***Gurawa ceylonica* Viraktamath and Gnaneswaran sp. nov. (Figs. 1-7, 38, 43-46, 63-64)**

urn:lsid:zoobank.org:act:DAB6D899-38BC-471B-8C49-CA352454BD35

Male: Pale brown. Anterior lobe of crown with median broad dark brown stripe, lateral margins of lobe and one spot, fuscous brown. Ridge between anterior and posterior lobe pale, spot on anterior margin of posterior lobe dark brown. Face dark brown, lateral margins pale ochraceous, elongate spot below antennal bases dark brown, lateral margins of genae, apex of clypeus and labium, fuscous brown. Pronotum with median line, lateral margins and stripe before lateral

margins, pale ochraceous, spot on either side of median line in anterior half, dark brown; median line on scutum and scutellum pale ochraceous, lateral faint stripe on scutellum fuscous in anterior half.

Female: Cinnamon brown, face much darker compared to male.

Head about 2.5 times longer than pronotum; crown laterally deeply incised and divided into anterior and posterior lobes, round ridge separating the anterior lobe, sublateral region with ridge, surface shagreened, posterolateral margins of anterior lobe strongly divergent. Frons with median keel in basal fovea. Pronotum with median and sublateral longitudinal ridges, more than three times as wide as long. Forewing 3.4 times as long as wide. Hind wing very small, not extending beyond base, 0.25 length of forewings. Hind femoral spinulation 2+0.

Male genitalia: Pygofer with dorsal margin concave beyond midlength, posterior margin rounded and ventral margin concave. Valve triangular, twice as broad at base as long medially. Subgenital plate about as long along inner margin as wide at base. Style about 3 times as long as wide at base, apophysis elongate, slightly curved laterally, 0.4 times as long as total length, with one prominent denticle on ventral margin before midlength. Connective with arms as long as stem, posterior margin of stem straight. Aedeagus curved dorsally and then anteriorly, with poorly developed hood, lateroapical margin with widely spaced prominent tooth, lateroapical spine longer than median lobe of shaft and divergent in posterodorsal view, gonopore subapical.

Female genitalia: Seventh sternite 1.8 times as wide as long, posterior margin concavely produced and medially concavely excavated.

Measurements: Male 3.6 mm long and 1.0 mm wide across eyes. Female 3.85 mm long and 1.0 mm wide across eyes.

Material examined: SRI LANKA: HOLOTYPE ♂, Peradeniya, 13.v.2008, R. Gnaneswaran (UASB). PARATYPE 1 ♀, same data as holotype but collected on 24.x.2008(UASB).

Remarks: *G. ceylonica* sp. nov. resembles *G. constricta* sp. nov. externally but has strongly divergent posterolateral margins of the anterior lobe of head. It also differs in the structure of aedeagus as given in the key.

***Gurawa constricta* Viraktamath and Gnaneswaran sp. nov. (Figs. 8-14, 39, 47-50, 65-66)**

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Ochraceous. Face with elongate spot beneath antennal bases, basal spot at lateral area of clypeal suture, spot on gena adjacent to Lorum, dark brown; anterior lobe spotted with fuscous. Head with anterior margin, spots on sublateral margin of lobe, spot each near base of crown on either side of median line, black; anterior lobe marked with fuscous brown. Pronotum

ochraceous with longitudinal ridges paler. Scutellum with one spot on anterior margin of scutum dark brown. Forewing cells pale brown, veins pale white. Labrum dark brown, mesosternum except median line and ventral most areas of mesopleura, dark brown. Spot on proepimeron dark brown. Basal abdominal sternites infuscated.

Head wider than long, longer (more than 1. 5 times) than median length of pronotum and also combined length of scutum and scutellum, slightly wider than pronotum; crown of vertex constricted thus dividing it into anterior small and posterior large lobes at position of ocelli, posterolateral margins of anterior lobe straight, posterior lobe with sublateral longitudinal ridge. Pronotum 2.5 to 3.0 times as wide as long, with median and sublateral carinae. Hind femoral spinulation 2+0. Forewing 2.9-3.4 times as long as wide; hind wings reduced, half as long as forewings.

Male genitalia: Pygofer with posterior margin slightly concave in posterior half, posterior margin rather truncate and ventral margin concave.Valve about twice as broad at base as median length. Subgenital plate as long along inner margin as broad at base. Style slightly more than twice as long as broad at base, apophysis 0.45 times as long as total length, with one prominent tooth in basal half. Connective with arms as long as stem, posterior margin of stem slightly concave. Aedeagus similar to that in *G. ceylonica*, lateroapical spines subequal to median lobe, and crossing over each other ventrad of median lobe in posterodorsal view, gonopore subapical on the dorsal surface.

Female genitalia: Seventh sternite 1.7 times as wide at base as long, posterior half of sternite narrowed distally and posterior margin concave with acutely rounded lateral angles.

Measurements: Male 3.5-3. 6 mm long, 0.95-1.0 mm wide across eyes. Female 3.6-3.7 mm long and 1.0 mm wide across eyes.

Material examined: INDIA: Karnataka: HOLOTYPE ♂, 35 Km W. Jog Falls, Kogar, 27.ix.1991, C.A. Viraktamath (UASB). PARATPES, 4 ♂, 2 ♀, data same as holotype (UASB, NPC).

Remarks: *G. constricta* sp. nov. is much paler than *G. ceylonica*. Both sexes have the same coloration unlike that in *G. ceylonica* where the female is much darker than the male. This and *G. ceylonica* also differs from other known species of *Gurawa* in the shape of head and structure of aedeagus as given in the key.

***Gurawa intermediata* Pruthi (Figs. 15-21, 40, 51-54, 67-68, 73-74)**

Gurawa intermediatus Pruthi1936: 107-108, text fig. 121, plate VIII, figs. 7, 7a. Datta 1988: 73-74.

Ochraceous brown. Faint median stripe on crown reddish brown, similar spot on upper part of face and spot below bases of antennae reddish to dark brown. Labium fuscous brown, mesosternum reddish brown, apical margin of clypellus fuscous brown.

Head as long or slightly longer than pronotum; crown of vertex laterally wrinkled, without ridges. Pronotum more than 2.5 times as wide as long, about as long as combined length of scutum and scutellum, without sublateral ridges. Forewings 2.5-2.7 as long as wide. Hind wings small, extending to 0.60-0.75 length of forewings.

Male genitalia: Pygofer with posterior half of dorsal margin concave, posterior margin slightly convex and ventral margin oblique. Valve twice as wide at base as median length, posterior angle acutely rounded. Subgenital plate triangular, about as broad at base as long along inner margin. Style slightly more than twice as long as wide at base, apophysis broad at midlength then tapered distally in dorsal view, 0.25 times as long as total length, with basal prominent tooth and 6-7 smaller distal teeth on ventral margin. Connective with arms slightly longer than stem, latter with median concavity on posterior margin. Aedeagus similar to that in *G. minorcephala* but hood with lateroapical spines more prominent and closer to each other, convergent but not overlapping, gonopore subapical on dorsal surface.

Female genitalia: Seventh sternite twice as wide as long, posterior margin with median concavity, lateral margins concave and rounded.

Measurement: Males 3.7-3.8 mm long and 1.3 mm wide across eyes. Female 3.8-4.2 mm long and 1.3 mm wide across eyes.

Material examined: Type material: INDIA: Holotype ♀, 'Gangtok, 6000ft, Sikkim,13.viii.1927, Bailey' '*G. intermediatus* sp. nov., H.S. Pruthi, Det. 1935' '5391/H7' (ZSI). Other material. INDIA: Jammu & Kashmir: 1 ♂, Pahalgam, Gulmarg, 22.vi.1985, J.S. Mann &Mandes. West Bengal: 1 ♀, Tiger Hill, 2578 m, 24.x.1981, C.A. Viraktamath; 1 ♂, Algarah, 1658 m, 27.x.1981, C.A. Viraktamath. Sikkim: 1 ♀, Gangtok, 1759 m, 10.vi.2005, C.A. Viraktamath (UASB).

Remarks: Identification of other material is based on the comparison with the type specimen. See under *G. minorcephala*.

***Gurawa minorcephala* Pruthi (Figs. 22-29, 41, 55-58, 69-70)**

Gurawa minorcephala Pruthi 1930: 29-30.Text figs. 41-42, plate II, figs. 10,10a, 10b. Datta 1988:74-75, figs. 126-127; Zahniser 2008: 22, figs. 77-85; Dai *et al*. 2011: 38, fig. 1.

Pale brown to brown with dark brown spots. Crown with median stripe dark brown to black. Face mottled with dark brown spots. Mesosternum dark brown. Front coxae entirely dark brown. Femora marked with dark brown.

Male genitalia: Pygofer with dorsal margin concave in posterior half, posterior margin slightly convex and ventral margin oblique. Valve 2.3 times as broad at base as long, posterior angle conically rounded. Subgenital plate 1.35 times as wide at base as long along inner margin. Style more than twice as long as wide at base, apophysis 0.25 as long as total length, tapering

distally with one prominent basal tooth followed by four smaller distal teeth on ventral margin. Connective with arms as long as stem, posterior margin rounded. Aedeagus in lateral view curved dorsally and in posterior view hood-like, with lateral margins dentate, lateroapical margin produced into a prominent spine directed anteriorly and not overlapping with each other, gonopore subapical.

Female genitalia: Seventh sternite about 1.5 times as long as wide, posterior margin with median and lateral shallow concavity, lateral angles bluntly rounded.

Measurements: Male 3.7-4.0 mm long and 1.2-1.3 mm wide across eyes. Female 3.9-4.1 mm long, 1.3-1.35 mm wide across eyes.

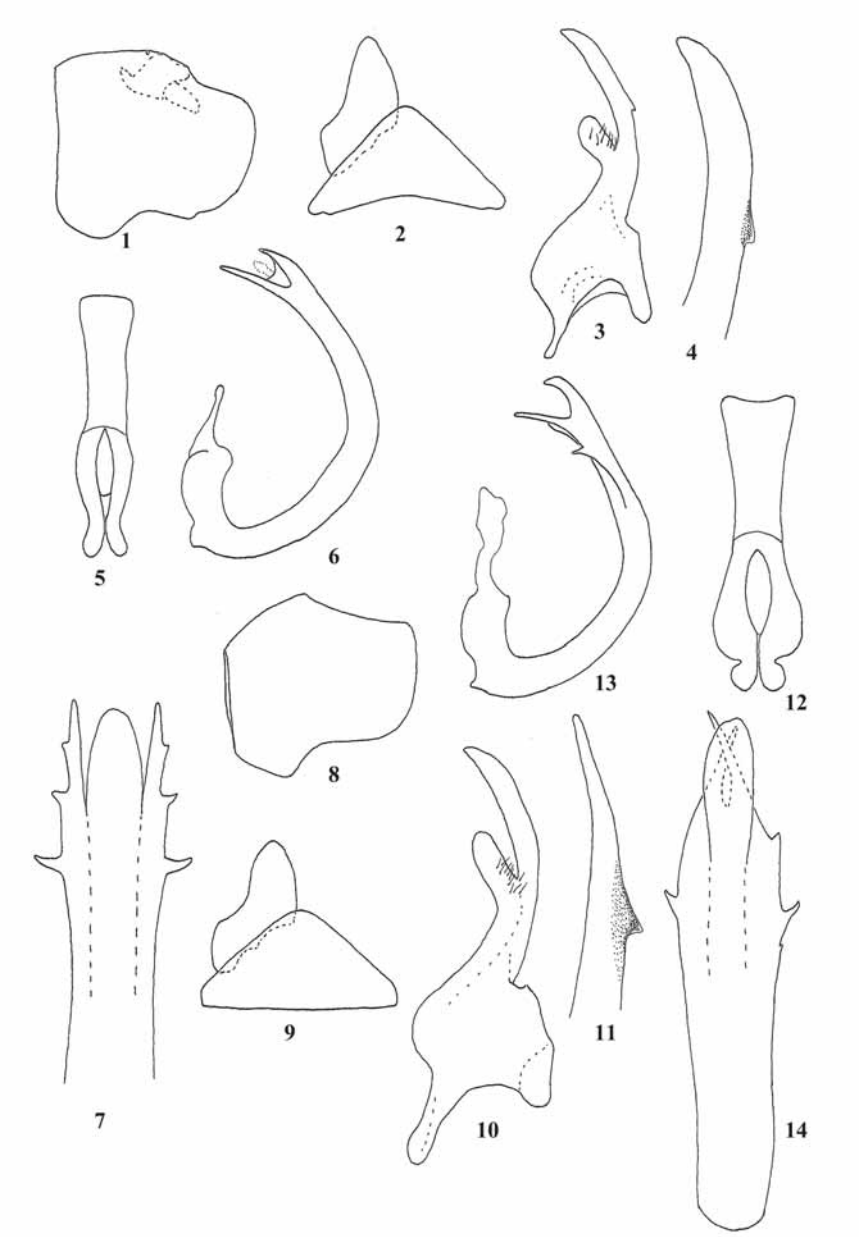
Material examined: Type material. PAKISTAN: Syntypes. 1 ♂, '687/H7' 'Jhikka Gali, 6730ft, Murree subdivision, Punjab, sta. 23, 17.ix.1928, H.S.Pruthi'; 1 ♀ same data, 1♂, 'Murree, ca 7242 ft, Punjab, (Light trap), sta 7, 4.ix.28, H.S.Pruthi' '690/H7'; 1 ♀, 'Kulduna, 7006 ft, Murree Subdivn. Punjab , sta 9, 6.ix.28, H.S.Pruthi'(ZSI). Other material. INDIA: Karnataka: 5 ♂, 1 ♀, Nandi Hills, 1467 m, 17.vii.1979, S.Viraktamath; 4 ♂. Same data but collected on 1.v.1976, B. Mallik (1 ♂), 1.v.1980, S. Viraktamath (1 ♂), 21.vii. 1975 (1 ♂) and 28.ix.1978 (1 ♂), C.A.Viraktamath; 1 ♀, Bannerghatta nr Bangalore, 26.i.1975, C.A.Viraktamath, 1 ♂, 2 ♀, same data but collected on 10.viii.1975; 2 ♂, 1 ♀, Jog Falls, 534 m, 17.xi.1976, C.A.Viraktamath; 1 f: 35 Km W. Jog Falls, 18.xi.1976, B. Mallik; 1 ♂, Mudigere, 970 m, 6.iv.1980, C.A.Viraktamath; 1 ♀, Donigar nr Sakleshpur, 7.ii.2005, C.A. Viraktamath;1 ♂, 2 ♀, Bangalore 10.viii.1986, Sivaramakrishnan. Kerala: 1♀, Walayar Forest, 305 m, 26.x.1975, C.A.Viraktamath. Tamil Nadu: 2 ♀, Oothu near Ootacamund, 29.x.1975, C.A.Viraktamath. West Bengal: 1 ♀, Algarah nr Kalimpong, 1638 m, 27.x.1981, C.A.Viraktamath; 1 ♀, 8 Km E Kalimpong, 29.x.1981, C.A.Viraktamath (UASB).

Remarks: Pruthi (1930) labelled one male and one female specimens as holotypes and remaining two specimens as paratypes. These are here considered as syntypes. *G. intermediata* and *G. minorcephala* resemble each other externally and also have similar male genitalia. They can however, be distinguished by the structure of the apex of the aedeagal shaft as given in the key.

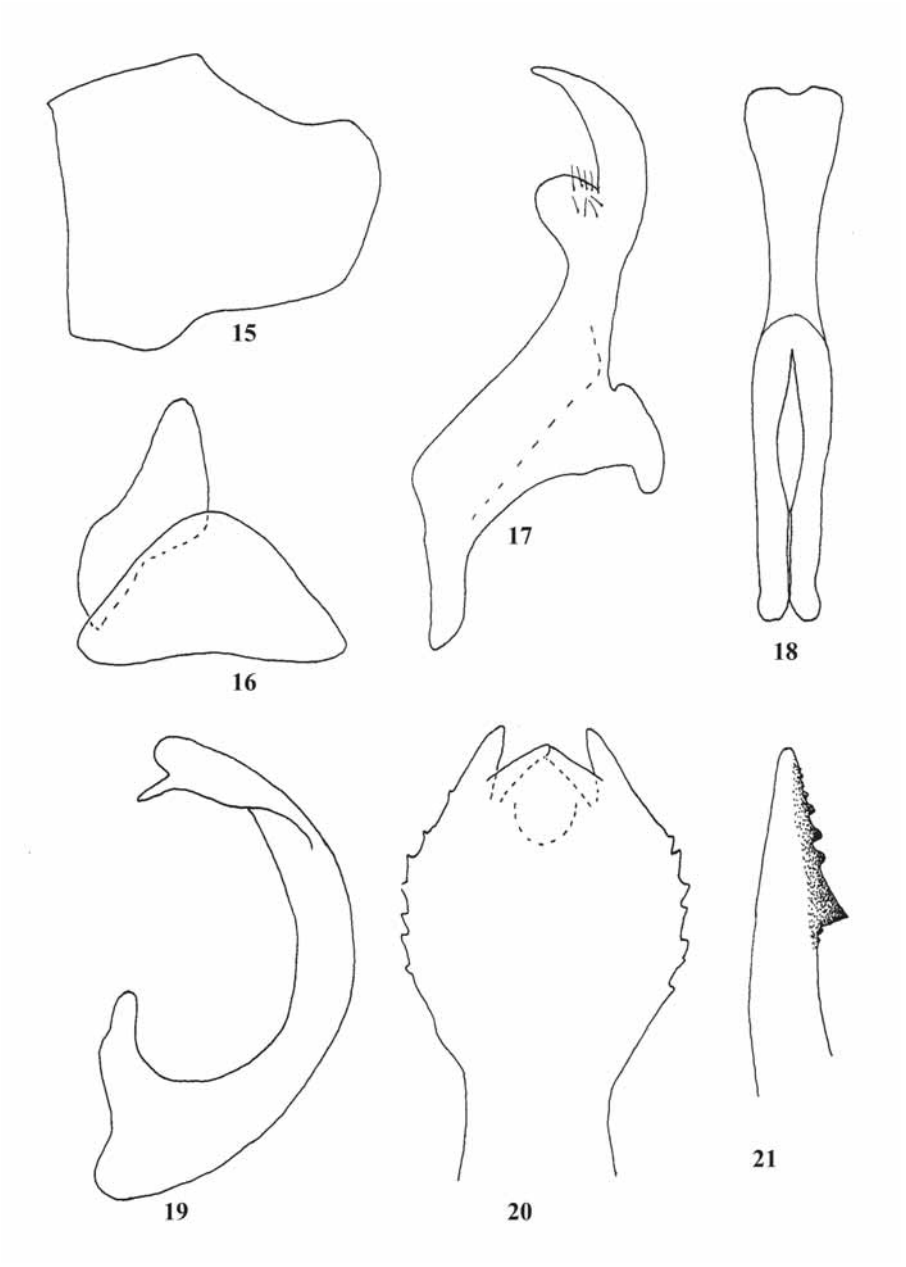
***Gurawa vexillum* Distant (Figs. 30-37, 42, 59-62,71, 72, 75)**

Gurawa vexillum Distant 1908: 263, fig. 169; Pruthi 1934: 77-78, Fig. 96; Datta1988: 75-76, fig. 128; Rao 1990: 23-25, fig. 4.

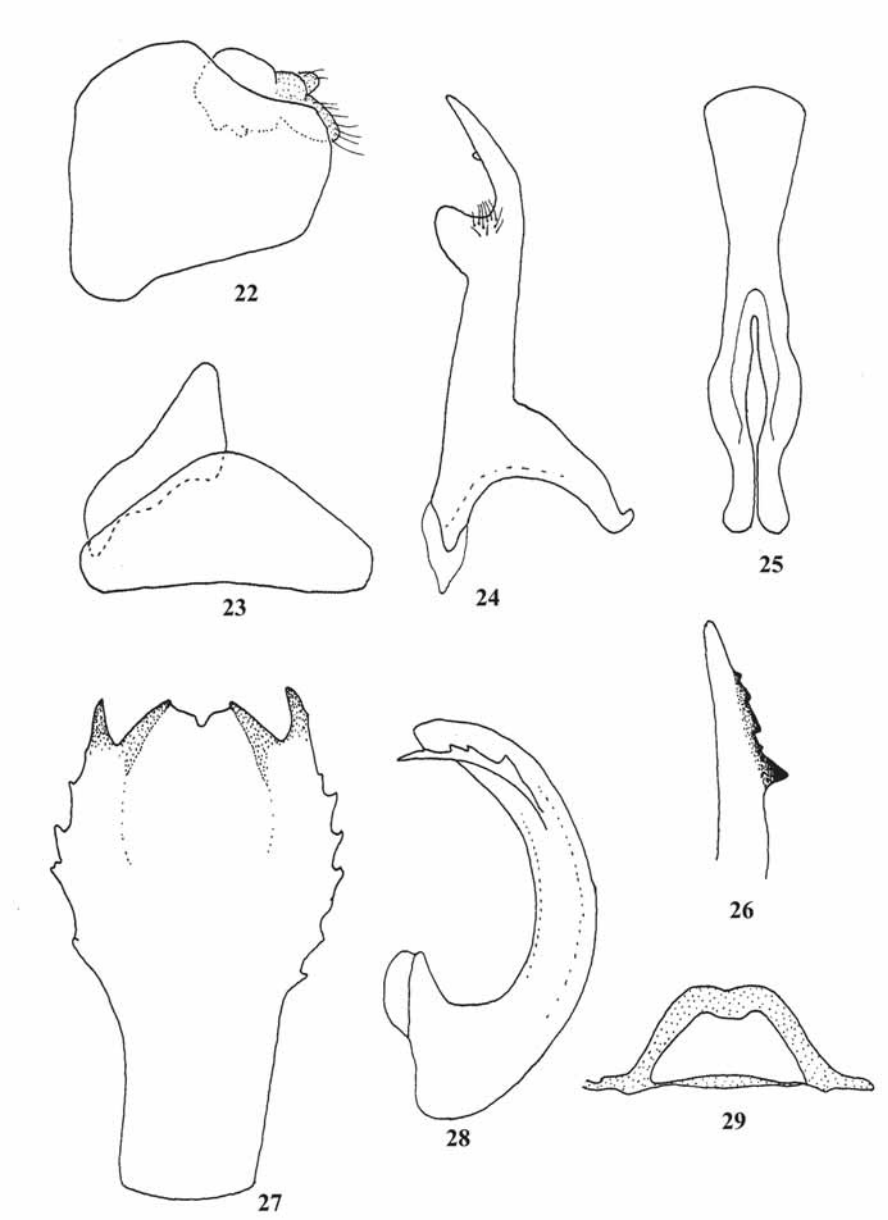
Pale brown to brown with darker spots. Crown with median stripe dark brown in darker specimens and reddish brown in paler specimens. Face mottled with dark brown spots. Mesosternum dark brown. Femora marked with dark brown in darker specimens.



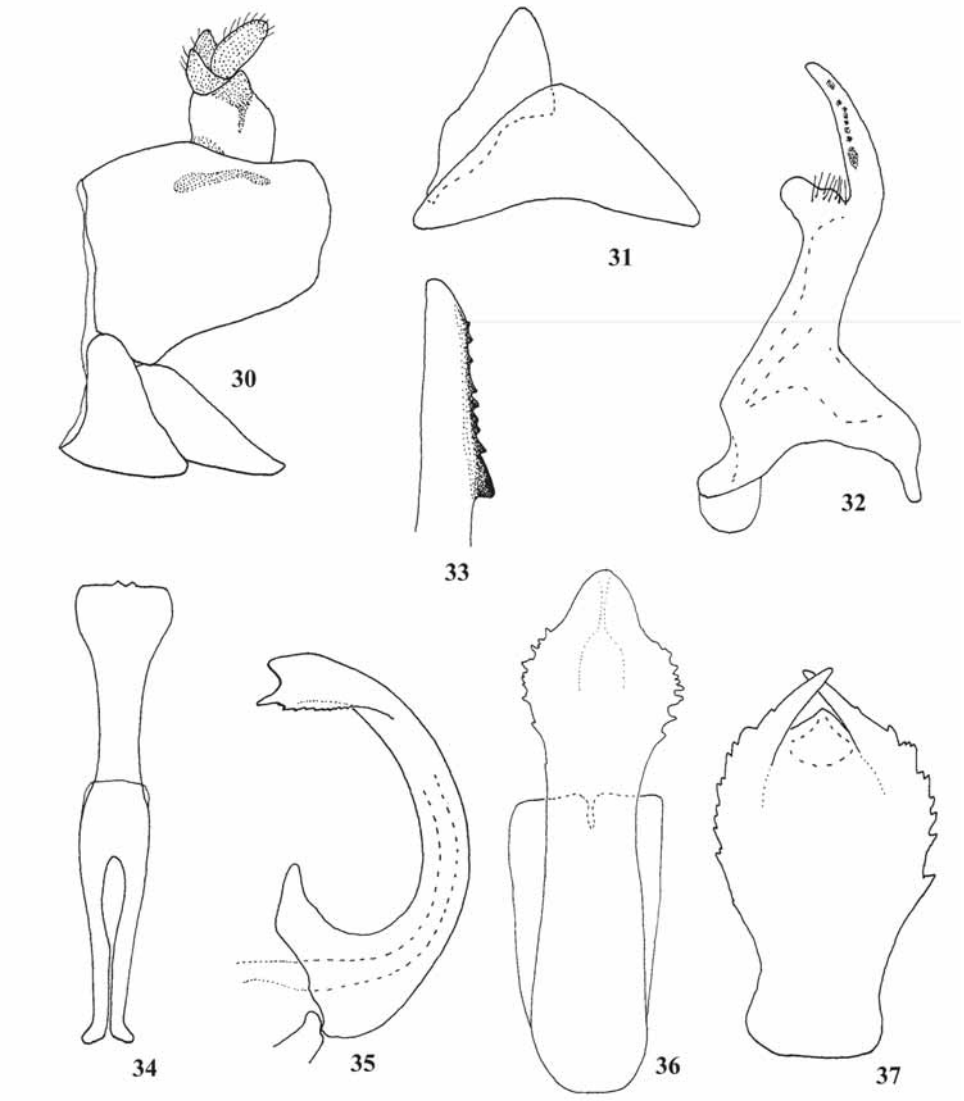
Figs. 1-14. Male genitalia of species of *Gurawa*. 1-7. *Gurawa ceylonica* sp. nov.: 1. Pygofer, lateral view; 2. Valve and subgenital plate, ventral view; 3. Style, dorsal view; 4. Apophysis of style, lateral view; 5. Connective, dorsal view; 6. Aedeagus, lateral view; 7. Apex of aedeagus, dorsoposterior view. 8-14. *Gurawa constricta* sp. nov.; 8. Pygofer, lateral view; 9. Valve and subgenital plate, ventral view; 10. Style, dorsal view; 11. Apophysis of style, lateral view; 12. Connective, dorsal view; 13. Aedeagus, lateral view; 14. Apex of aedeagus, dorsoposterior view.



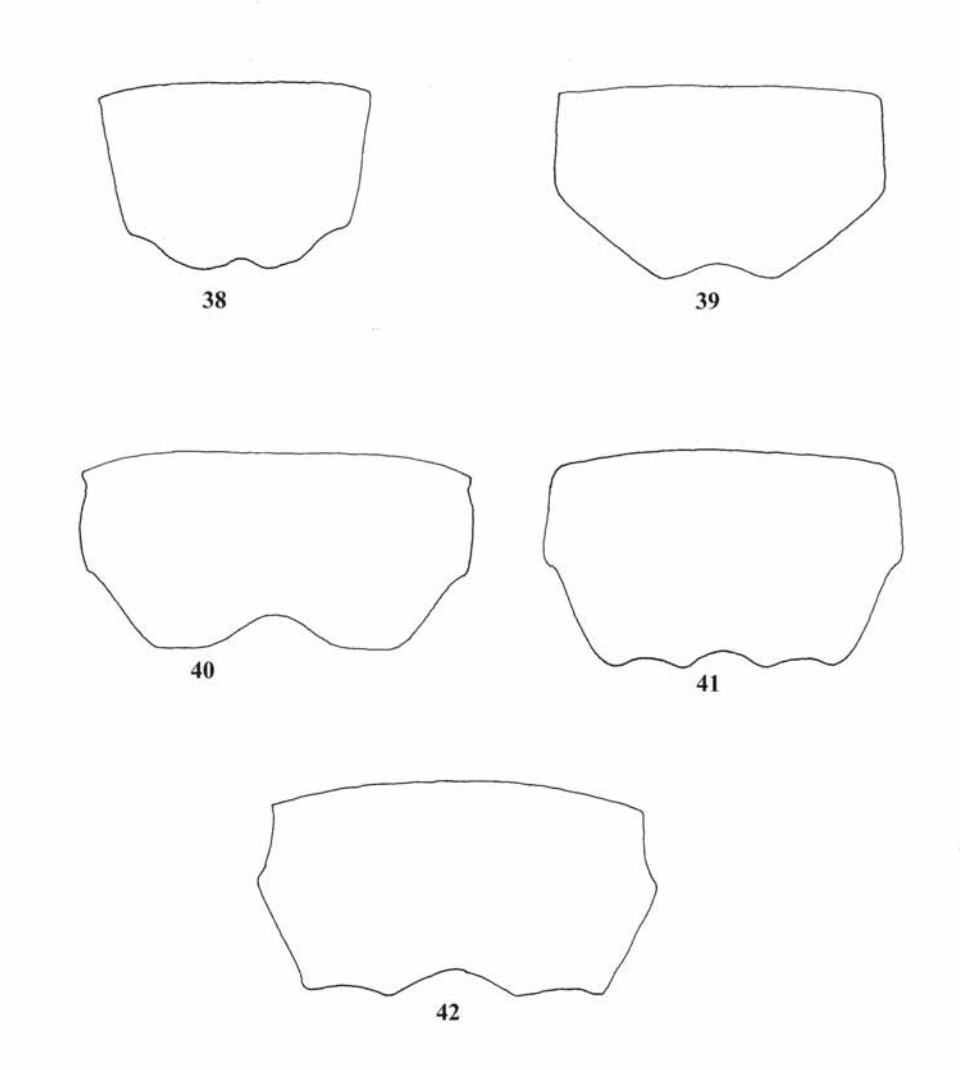
Figs. 15-21. Male genitalia of *Gurawa intermediata* Pruthi: 15. Pygofer, lateral view; 16. Valve and subgenital plate, ventral view; 17. Style, dorsal view; 18. Connective, dorsal view; 19. Aedeagus, lateral view; 20. Apex of aedeagus, dorsoposterior view; 21. Apophysis of style, lateral view.



Figs. 22-29. Male genitalia of *Gurawa minorcephala* Pruthi: 22. Pygofer, lateral view; 23. Valve and subgenital plate, ventral view; 24. Style, dorsal view; 25. Connective, dorsal view; 26. Apophysis of style lateral view; 27. Apex of aedeagus, dorsoposterior view; 28. Aedeagus, lateral view; 29. Connective, dorsal view.



Figs. 30-37. Male genitalia of *Gurawa vexillum* Distant: 30. Male genital capsule, lateral view; 31. Valve and subgenital plate, ventral view; 32. Style, dorsal view; 33. Apophysis of style, lateral view 34. Connective, dorsal view; 35. Aedeagus, lateral view; 36.Aedeagus, ventroposterior view; 37.Apex of aedeagus, dorsoposterior view.



Figs. 38-42. Female seventh sternite, ventral view of species of *Gurawa*. 38. *Gurawa ceylonica* sp. nov.; 39. *Gurawa constricta* sp. nov.; 40. *Gurawa intermediata* Pruthi; 41.*Gurawa minorcephala* Pruthi; 42.*Gurawa vexillum* Distant.

Male genitalia: Pygofer with dorsal margin in posterior half slightly concave and ventral margin oblique and sinuate. Valve triangular, 2.5 times as wide at base as long medially, posterior margin more acutely rounded compared to that in *G. minorcephala*. Subgenital plate triangular, about 1.25 times as wide at base as long along inner margin. Style about twice as long as wide at base, apophysis rather straight in basal 0.75 then laterally curved, slightly, 0.3 times as long as total length, with one basal stout tooth followed by 8 smaller teeth on ventral margin. Connective with stem longer than arms, with median concavity on posterior margin. Aedeagus as in *G. minorcephala* but hood with lateroapical spines prominent, longer and overlapping each other at apex in posterodorsal view, gonopore subapical.

Female genitalia: Seventh sternite about twice as broad as long with prominent median concavity and less prominent lateral concavity, lateral angles acutely rounded.

Measurements: Male 3.65-mm long and 1.2-1.3 mm wide across eyes.Female 4.0-4.2 mm long and 1.3-1.4 mm wide across eyes.

Material examined: INDIA: Himachal Pradesh: 1♀, Kufri, 2600 m, 15.x.1979, C.A. Viraktamath; 1♂, Manali. 15.x.1981, I. Dworakowska. West Bengal: 2♀, Kurseong, 1483 m, 22.x.1981, C.A.Viraktamath (1♀) and S. Viraktamath (1♀); 1♀, 8 Km E. Kalimpong, 29.x.1981, C.A. Viraktamath; 2♂, 3♀, Algarah nr Kalimpong,1788 m, 7.vi.2005, C.A. Viraktamath (UASB).

Remarks: Described from a single specimen from “Sikhim; Mungphu (Atkinson, Coll. Dist.)”. Identity of other specimens is provisional based on the external appearance and proximity to the type locality. The holotype specimen (Fig. 75) has lost its abdomen (M.D. Webb, pers. com.). Specimens provisionally identified as *G. vexillum* have heads either as long as or slightly longer or shorter than pronotum. Specimens from Algarah are much darker especially the females.

ACKNOWLEDGEMENTS

We are thankful to Mr M.D. Webb (BMNH) for providing information on the holotype of *G. vexillum* Distant and also its photograph (Fig. 75). Mr Webb and Dr Dai Wu (Northwest A & F University, Yangling, China) provided constructive criticism on an earlier draft of this paper. Dr Yeshwanth, H.M. (UASB) helped in the preparation of the plates and also provided the field photographs of the species of *Gurawa*.

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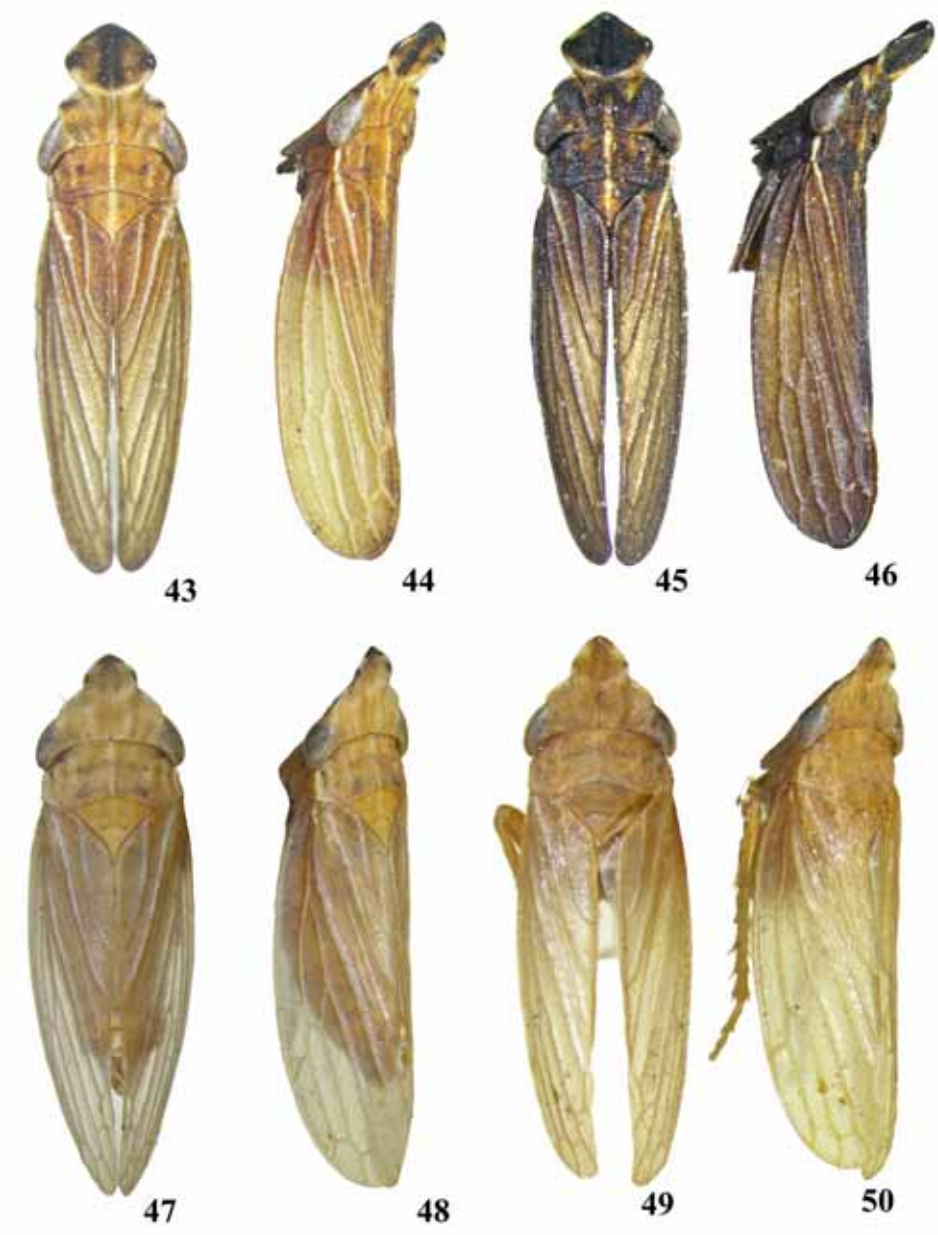
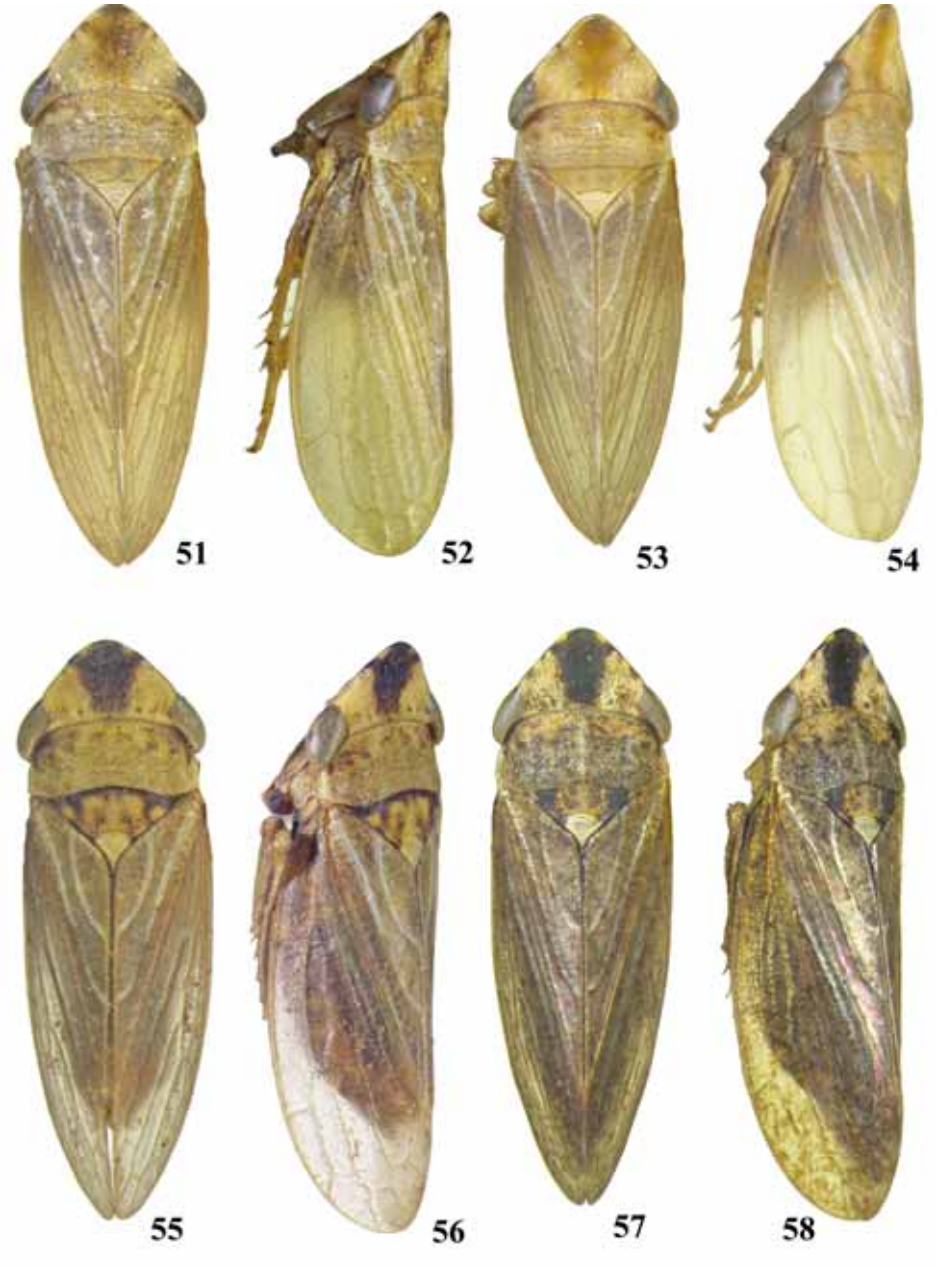
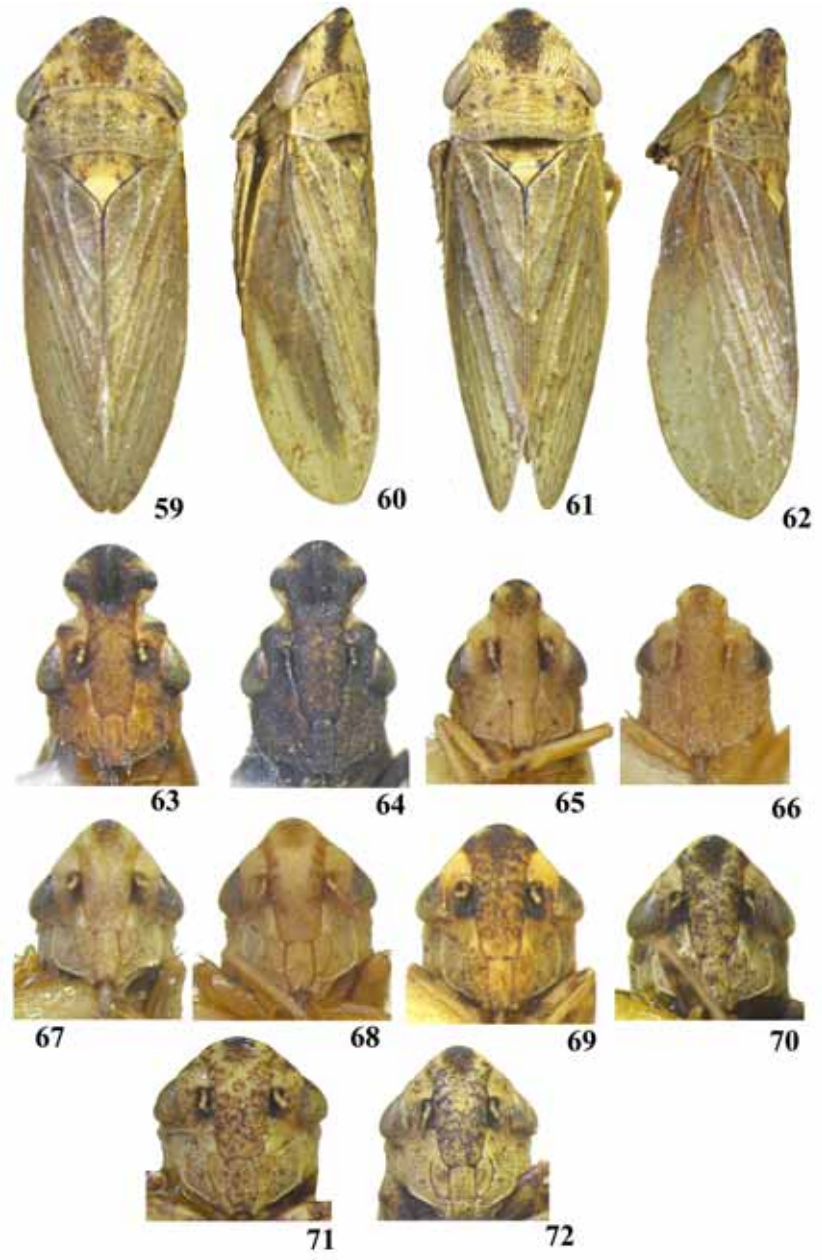


Figs. 43-50. Habitus of species of *Gurawa*. 43-46. *Gurawa ceylonica* sp. nov.; 47-50. *Gurawa constricta* sp. nov. : Males: 43& 47. Dorsal view; 44 & 48. Lateral view. Females: 45& 49. Dorsal view; 46 & 50. Lateral view.



Figs. 51-58. Habitus of species of *Gurawa*. 51-54. *Gurawa intermediata* Pruthi; 55-58. *Gurawa minorcephala* Pruthi: Males 51 & 55. Dorsal view; 52 & 56. Lateral view. Females: 53 & 57. Dorsal view; 54 & 58. Lateral view.



Figs. 59-72. Habitus and face of species of *Gurawa*. 59-60. Male *Gurawa vexillum*, dorsal and lateral views; 61 & 62.Female *G. vexillum*, dorsal and lateral views; 63 & 64.*G. ceylonica* male and female face; 65 & 66. *G. constricta* male and female face; 67 & 68. *G. intermediata* male and female face; 69 & 70. *G. melanocephala* male and female face; 71 & 72. *G. vexillum* male and female face.

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Figs. 73-75. Species of *Gurawa*. 73-74. Female *Gurawa intermediata* in natural habitat. 75. *Gurawa vexillum* holotype, dorsal view.

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(Received 03-06-2014; accepted 21- 11- 2014)

ENTOMON 38(4): 213 - 220 (2013)
Article No. ent.38403

SEM studies and re-description of *Aleurocanthus husaini* (Corbett) (Hemiptera: Aleyrodidae) infesting citrus in Central India

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ABSTRACT: Biology of the citrus blackfly, *Aleurocanthus husaini* (Corbett, 1939) is studied in Central India. There were three over lapping generations in a year. The life stages viz., egg, first, second, third and fourth instar (puparium) and adults are described on the basis of light and scanning electron microscopic (SEM) studies. The structural details of antennae, genitalia, and wings of adult male and female have been re-described.

Key words: SEM studies, re-description, citrus blackfly, *Aleurocanthus husaini*, developmental stages

INTRODUCTION

The citrus blackfly (CBF) is a major pest of citrus crops in tropical countries. In India, its infestation was sporadic in orange orchards of Vidarbha region (Central India) in 1976, but spread in surroundings and in larger area by 1982 caused set back to the orange industry. CBF and its young stages feed on phloem sap of host leaves, excrete honeydew that promotes the growth of sooty mold over surface of leaf and subsequently block photosynthesis affecting the plant growth and fruiting quality (Raina *et al*., 1988).

Citrus trees are infested by many species of the genus *Aleurocanthus* and have been identified mainly on the basis of external features of fourth instar or puparium (Mound and Halsey, 1978). The diagnostic differences of the Indian citrus feeding species, *Aleurocanthus* species

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are not available, and hence the study was undertaken to re-describe using morphological characters of immature and adults including the biology and life stages of *Aleurocanthus husaini.*

MATERIALS AND METHODS

Survey: Periodical survey was conducted from Feb 2009 – Mar 2011 in orange growing areas of Nagpur and Amravati districts to study the life cycle and collection of developing stages of the CBF.

Mounting for Light microscopy: The eggs, first, second, third and fourth instars were carefully dislodged from the infested leaves from Central India. They were treated with 10% KOH for a few days, washed with distilled water, dehydrated in ethyl alcohol series, cleared in xylene and whole mounts were prepared for light microscopic observations.

Scanning electron microscopy: For SEM the specimens were dehydrated, dried, placed on stub, coated with gold in Polson automatic unit (E 5200) and photographed using Stereo scan 250 MK III SEM at Regional Sophisticated Instrumentation Centre (RSIC), RTM Nagpur University, Nagpur.

Material examined: All the life stages from, Nagpur and Amravati districts of Central India, and about 25puparia on slides and on *Citrus* leaves, deposited in the collection of the Centre for Sericulture and Biological Pest Management Research (CSBR), RTM Nagpur University, Nagpur and also deposited at Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

RESULTS

Description: Aleurocanthus husaini (Corbett)

Generation: The citrus black fly, *A. husaini* completed its cycle through egg, first, second, third and fourth pupal instar before becoming an adult. The life cycle was greatly influenced by the prevailing climatic conditions and completed 2.9 – 3.1 generations in a year. The first generation occurred between March to June and took about 82 - 113 days, the second began at the onset of monsoon (Jun - Oct) and took 95 - 129 days and the third cycle initiated during winter (Nov – Feb), which took 91 – 133 days.

Life stages:

Egg: The female laid 2-3 egg spirals; each spiral contained 12-30 eggs (Fig. 1). The eggs are bean-shaped, about 0.24 mm long and 0.11mm wide. The eggs adhere to the lower surface of leaf by pedicel in stomata and have hexagonal texture on the surface of chorion (Fig. 2). The eggs appear creamy-yellow just after oviposition, which turned dark brown with age.

First instar: It is creamy-yellow, elongate and about 0.3 mm long and 0.14 mm wide. The first instar possesses a pair of ocelli and four pairs of dorsal spines; one paired each on cephalothorax and abdomen. There are seven abdominal segments, three caudal tracheal folds with stipples and distinct closed type of vasiform orifice (Figs. 3 and 4).

Second instar: Dorsum convex with smoothly crenulate margin, about 0.45 mm long and 0.22 mm wide. Dorsum is dark except at thoracic and thoraco-abdominal sub marginal region. There are 11 pairs of spines arranged on the dorsum, of which six pairs are located on cephalo-thoracic and five pairs on abdominal region (Figs. 5, 6 and 7).

Third instar: Ovate, convex and broader at the anterior end. Dorsum is black except at cephalo-thoracic region and peripheral margin. The females measured about 0.52 mm long and 0.32 mm wide whereas males were 0.42 mm long and 0.32 mm wide. Dorsum with 17 pairs of spines, of which nine are distributed on cephalo-thorax and eight on abdominal segments (Figs. 8 and 9).

Fourth instar (puparium): Oval or elliptical. Dorsum is convex, dark black and highly sclerotized (Fig. 10). The sex is readily distinguishable. Females measured 1.08 mm long and 0.7 mm wide, males 0.8 mm long and 0.42 mm wide, respectively. Ventrally margin possesses distinct lobulate teeth (Fig. 11) and 6 teeth in 100 microns (Fig. 12). Longitudinal and transverse moulting sutures extended up to sub-margin (Fig.13). The tracheal folds are not distinct on abdominal segments. Orifice sub-cordate and measured about 50 μm long and 36 μm wide, having 38 μm long and 33 μm wide lingula (Fig. 14). About 32 pairs of stout and conspicuous spines of variable length ranged from 38 μm to 392 μm in length, out of which 14 pairs are distributed on the cephalo-thorax and 18 on abdomen (Table 1). Remnants of exuviae of earlier instars often remain stacked upon median area.

Adult:

Female: The adult female measured 1.26 mm in length. The body is coated with a fine waxy powder, which gives it a gray appearance. The head appears reddish black with a pair of reddish brown eyes and creamy antennae five-segmented, measured about 0.188mm in length. The pro, meso and meta thoracic legs measured 0.620, 0.471 and 0.390 mm in length, respectively. The wings are smoky gray with four transparent halo spots. Fore wing measured about 1.21 mm in length and 0.437 mm in width, having serrate margin with fine microtrichia at the tip of serration. Hind wing measured about 1.01 mm and 0.298 mm in length and width, respectively (Fig.15). Ovipositor measured about 0.091mm long.

Male: Male smaller than the female and appears cylindrical tapering towards posterior end and measured about 0.95 mm in length. The head appears blackish with pair of reddish brown eyes and five segmented cream coloured antennae, measured about 0.161 mm in length. The leg of male also consists of pro, meso and metathoracic legs and measured 0.529, 0.428 and 0.371 mm in length respectively. The wings are smaller than female, fore wing 0.739 mm long

TABLE 1. Morphological characters of fourth instars of earlier described whitefly *Aleurocanthus* sp.

Whitefly	Shape and size	No. of spines	Orifice shape	Marginal teeth in 100 ìm	Reference
A. spiniferus (Quaint.)	broad at abdominal region	32 + 32 14 cephalo-thoracic, 18 abdominal	sub-circular to sub-cordate compressed	rounded, 8 teeth	Silvestri (1927)
A. woglumi (Ashby)	broadest at abdominal region	33 + 33 14 cephalo-thoracic, 19 abdominal	circular	rounded 5-6 teeth	Silvestri (1927)
*A. husaini** (Corbett)	oval or elliptical, uniform at both ends	32 + 32* 14 cephalo-thoracic, 18 abdominal	sub-cordate	rounded 5 teeth	Corbett (1939), Mound and Halsey (1978)

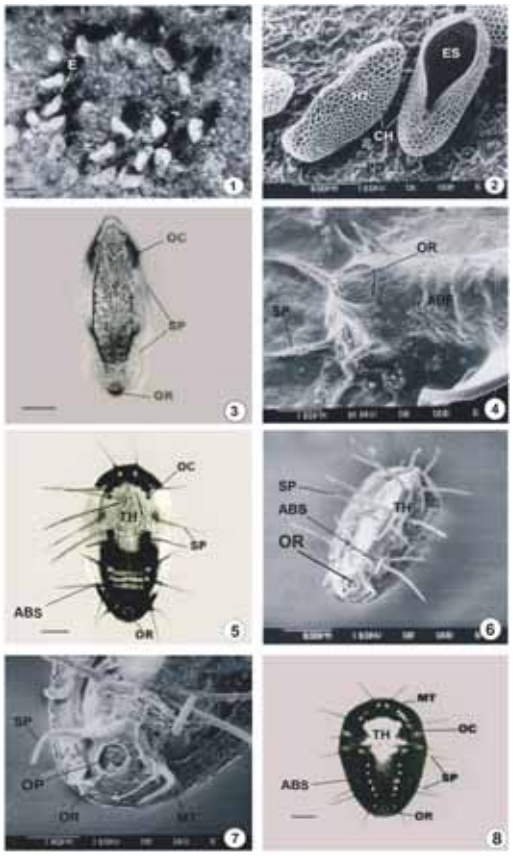
*Re-described

and 0.356mm wide, whereas hind wing measured 0.725 mm in length and 0.246 mm in width. The abdomen is slender, gradually tapering towards the posterior end. The last abdominal segment modified in to forceps like claspers measured about 0.088 mm in length. The aedeagus of male genital organ is present in between claspers, measured about 0.084 mm in length (Fig.16).

DISCUSSION

The period required to complete the life cycle of citrus blackfly depends on the environmental condition prevailing in different climatic zones. In Central India, *A. husaini* completed 2.9 – 3.1 generations in a year. At Fort Lauderdale in Florida, *A. woglumi* completed 3.6 generations per year, whereas at Lake Alfred, Florida only 3.0 to 3.1 generations (Dowell *et al*., 1981). In Punjab, *A. woglumi* completes 2.0 generations in a year (Garg, 1978), whereas in Bahama, Mexico and El Salvador it has more than four generations (Smith *et al*., 1964; Falanders, 1969; Quezada, 1974). Kuwana and Ishii (1927) also recorded four generations for *A. spiniferus* in Japan, while reports from Guam showed the presence of five or six generations (Peterson, 1955). In the present study in Central India *A. husaini* completed 2.9 – 3.1 generations in a year.

During the present study it was observed that the characters of fourth stage of *Aleurocanthus husaini* (Corbett, 1939) differed in many respect from those of the earlier described species of *Aleurocanthus* (Table 1). This study highlights the variations in the number of marginal teeth present in 100 µm length of fourth instar and number of halos in the forewing of adult. The inverted ‘v’ shaped notch present on the lower anal margin near the basal articulation of the



Figs. 1-2. Eggs of *Aleurocanthus husaini*

Fig. 1. Egg (E) spiral on the underside of leaf. (whole mount).Bar = 0.26 mm

Fig. 2. Hexagonal texture (HT) on the chorion (CH) and pedicel (PD) inserted into the stomata of leaf and showing empty shell (ES). SEM.

Figs. 3-4. First instar of *Aleurocanthus husaini*

Fig. 3. Elongated oval first instar, OC – ocellus, OR – orifice, SP – spine. (Whole mount) Bar = 0.053 mm.

Fig. 4. Vasiform orifice (OR) of first instar filled with lingual (LN) and (ABS) abdominal sutures / Median elevation. SEM.

Figs. 5 - 7. Second instar of *Aleurocanthus husaini*

Fig. 5. Convex second instar, OC – Ocellus, TH- Thorax, OR – Vasiform orifice, SP – spine, ABS - Abdominal sutures/Median elevation. Whole mount. Bar = 0.081mm.

Fig. 6. Dorsal view of second instar, TH- Thorax, OR – Vasiform orifice, SP – spine, ABS- Abdominal sutures/Median elevation. SEM.

Fig. 7. Vasiform Orifice (OR) with lingula (LN) of second instar. SEM.

Figs.8 - 9.Third instar of *Aleurocanthus husaini*

Fig. 8. Ovate third instar, MT – marginal teeth, OC – ocellus, OR – Vasiform orifice, SP – spine, ABS - Abdominal sutures/Median elevation. Whole mount. Bar = 0.107 mm

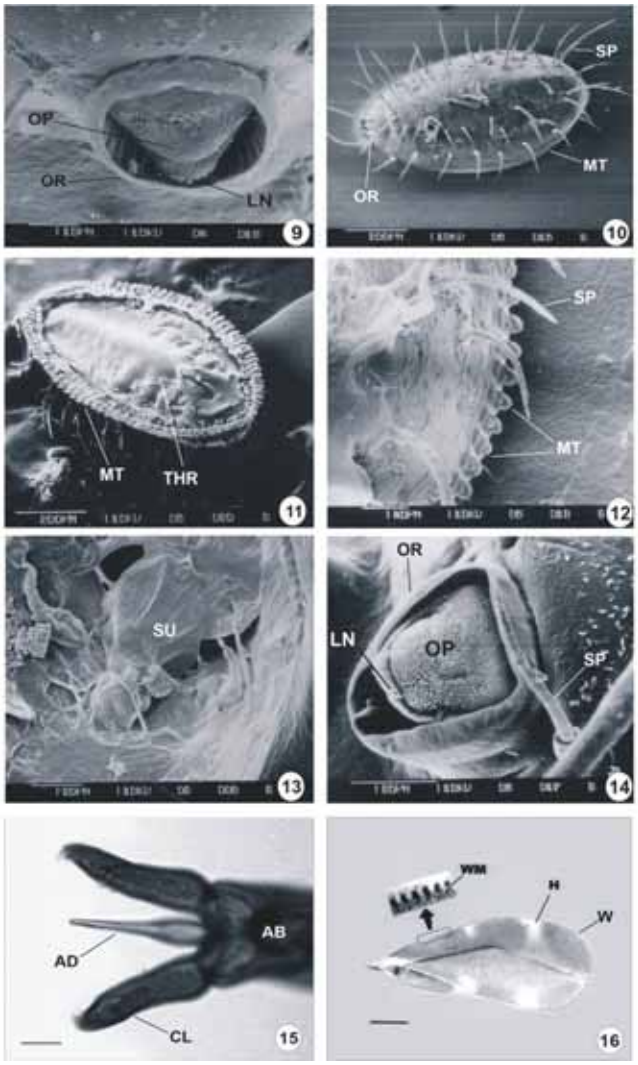


Fig. 9. Vasiform orifice (OR) with operculum (OP) and lingula (LN). SEM.
Figs. 10 - 14. Fourth instar of *Aleurocanthus husaini*
Fig. 10. Dorsal view of fourth instar OR – Vasiform orifice, SP – spines MT-Marginal teeth. SEM.
Fig. 11. Ventral view of Fourth instar, MT-Marginal teeth, THR-Thoracic region SEM.
Fig. 12. Lobulate marginal teeth (MT) of fourth instar. SEM.
Fig. 13. Thoracic region showing suture (SU) of Fourth instar. SEM
Fig. 14. Subcircular orifice (OR) with wide lingula (LN). SEM.
Figs. 15 - 16. Adult of *Aleurocanthus husaini*
Fig. 15. Dorsal view of female genitalia. AB- Abdomen, CL- Claspers, AD- Aedeagus. Bar = 0.024 mm
Fig. 16. Fore wing (W) of adult female showing four halo spots (H). Note the magnified view of wing margin (WM) with setae on each tooth. Bar = 0.20 mm

forewing as described by Corbett (1939) was not observed in the specimens found in Central India. The number of spines in *A. spiniferus* (Quaint.) is similar to *A. husaini* however, shape and size of fourth instar and number of marginal teeth present in 100 ìm differed. The fourth instar of *A. woglumi* (Ashby) is entirely different from that of *A. husaini* in shape and size, number of spines, orifice size and marginal teeth. Martin (2011) examined and confirmed that, fourth instar and adult specimens collected from the Central India is *A. husaini.*

We observed that the adult male and female of *A. husaini* differed in their shape and size. Female is large with round and broad abdomen as compared to short, slender and thin abdomen of male. The last abdominal segment is transformed for oviposition in female and forms claspers and adeagus in male (David and Thenmozhi, 1995; Chen and Ko, 2007). The shape of the claspers and adeagus in *A. husaini* is different from other hemipteran species. However, no detailed morphological description of adult stages of *A. husaini* or closely related to *Aleurocanthus* has been reported yet. This study provides re-description on the structural morphology of egg, nymphal and adult stages of *A. husaini* (Corbett), compared to Corbett (1939). It is further suggested that the description of adult characters may also be considered while identifying any whitefly species.

ACKNOWLEDGEMENTS

We are grateful to ICAR, New Delhi and USDA, for financial assistance. Thanks are also extended to Mr. Chandrakant Sarodey and Mr. Rahul Acharya for light microscopic and SEM photographic assistance.

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(Received 03-06-2014; accepted 30.10.2014)

ENTOMON 38(4): 221 - 226 (2013)
Article No. ent.38404

Predatory potential Of *Chrysoperla zestrowi* Sillemittenry and *Cryptolaemus montrouzieri* (Mulsant) on papaya mealybug, *Paracoccus marginatus* (Williams And Granara De Willink)

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ABSTRACT: Predatory potential of *Chrysoperla zestrowi* Sillemittenry and C*ryptolaemus montrouzieri* (Mulsant) was investigated in the laboratory. Both predators were found feeding on all the nymphal instars of *Paracoccus marginatus* (Williams and Granara de Willink). Third instar larvae of *C. zestrowi* were the most voracious feeder and consumed significantly higher number of ovisacs, first, second and third instar nymphs of mealybug as compared with first and second instar larvae of the predator. Similarly fourth instar grub of *C. montrouzieri* consumed higher number of ovisacs, first, second and third instar nymphs of mealybug. The results indicate the potential of *C. zestrowi* and *C. montrouzieri* in the the biological control of *P. marginatus.*

Key words:predatory potential, *Chrysoperla zestrowi*, *Cryptolaemus montrouzieri*, papaya mealybug, *Paracoccus marginatus* .

INTRODUCTION

Papaya is a popular fruit crop extensively grown in India. Mealybug, *Paracoccus marginatus* (Williams and Granara de Willink) is causing economic damage many agricultural and horticultural crops in India. Papaya mealybug is a native of Mexico and/ or Central America and was first described by Williams and Granara de Willink (1992). It is a highly polyphagous pest of 133 plant species belonging to 48 families (Sakthivel *et al.,* 2012). Due to growing environmental and economic concerns involved in the use of synthetic chemicals, there is a dire need to develop alternate measures for the suitable management of *P. marginatus.* In this context biological control need to be explored for controlling mealybug. The coccinellid predator,

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C. montrouzieri is one of the most commonly used bio-control agent in various parts of the world. It has played a major role in the natural control of different sucking pests especially mealybugs (Mani and Krishnamoorthy, 2008; Shylesa *et al.*, 2011). Green lacewing, *C. zestrowi* commonly known as aphid-lion is a general predator of a wide range of pest species such as mealybugs, aphids, thrips, whiteflies and mites (Yadav and Pathak, 2010).

Detailed studies on the use of *C. montrouzieri* and *C. zestrowi* for the biological control of *P. marginatus* are lacking and hence detailed studies were undertaken under laboratory conditions.

MATERIALS AND METHODS

Potatoes are used as an alternative food source for rearing of mealybugs (Serrano and Laponite, 2002). Seed potatoes with eyes were brought from local markets, washed and disinfected in 5% Sodium hypochlorite solution. After cleaning, the potatoes were treated with gibberlic acid 100 ppm solution for half an hour and placed under dark condition in wet gunny bags for four to five days to induce early sprouting. The tubers were then sown in plastic basins filled with moist sand. Before filling, the sand was sterilized in hot air oven at 1000^{o}C to prevent infestation by any pathogen which might induce rotting of tubers. Crawlers collected from the field were introduced on the green sprouts when they reached a height of 15-20 cm using a camel hair brush and mass cultured continuously for several generations under laboratory condition.

The two predators *C. montrouzieri* and *C. zestrowi* were reared using the stock supplied by the National Bureau of Agriculturally Important Insects, Banglore. The adults of *C. montrouzieri* were mass reared on *Maconellicoccus hirsutus* (Green) infesting pumpkins (*Cucurbita moschata* Duchense) treated with carbendazim (1gL^{-1}) to avoid fungal attack and the wounds were treated with wax. The methodology as described by Babu and Azam (1987) was followed for mass culturing of the predator.

For assessing the feeding potential of the predators two experiments were conducted.

i) No choice feeding -

The feeding potential of the larval instars of *C. zestrowi* (3 nos.) and *C. montrouzieri* (4 nos.) were individually collected from the mass cultures maintained separately in the laboratory. One each of these larva was transferred to Petri dish (9 cm diameter). From the culture of mealybug known number of ovisac, first, second and third instars collected separately and provided in petridish separately for the first, second and third nymphal instars of both predators. Each treatment was replicated eight times. The number of prey insects consumed was recorded daily. Fresh ovisacs and mealybugs were provided to the predators until they reached the next instar. In this way, the number of prey insects consumed during each larval instar was recorded. The experiment was laid out in Completely Randomized Design with four replications

ii) Free choice feeding -

In this experiment, single larva of each instars of the predators was introduced into petridish (9 cm diameter) with the help of camel hair brush along with known number of mealybugs of 1-3 nymphal instars for feeding. Free choice feeding of each predator instar on each instar of *P. marginatus* was recorded daily till the completion of each instar of the predator. The experiment was laid out in Completely Randomized Design with four replications.

The data were subjected to statistical analysis.

RESULTS AND DISCUSSION

Predation of *C. zestrowi*

No choice condition-

Feeding efficacy of different larval stages and adult of the predator was studied (Table 1). The third instar larvae of *C. zestrowi* consumed higher number of 3.25 ovisacs, 330.75 first instar, 120.63 second instar and 87.25 third instar nymphs of *P. marginatus* which differed significantly from 1.38 ovisacs, 109.25 first instar, 37.88 second instar and 12.63 third instar consumed by first instar *C.* carnea. The second instar *C. zestrowi* consumed 1.88 ovisacs, 206.13 first instars, 69.88 second instars and 37.75 third instar nymphs of *P. marginatus*. Third instar predator proved to be the most voracious feeder of all the nymphal instars of *P. marginatus* compared to first and second instars. The reason for higher feeding potential of third instar might be due to its large size than other developmental stages of the predator.

Free choice condition -

The different prey stages of mealybug were offered together to different larval instars of *C. zestrowi* (Table 2). The third and second instar larvae of *C. zestrowi* consumed 23.50 and

Table 1. Feeding potential of *C. zestrowi* on different instars of *P. marginatus* (No choice condition)

Different Instars of *C. carnea*	Total number of different stages of mealybug consumed* (mean ± SE)			
	Ovisac	1st instar nymph	2nd instar nymph	3rd instar nymph
1st	1.38 ± 0.18 c	109.25 ± 1.37 a	37.88 ± 0.76 a	12.63 ± 0.26 a
2nd	1.88 ± 0.13 a	206.13 ± 3.78 b	69.88 ± 1.04 b	37.75 ± 0.59 b
3rd	3.25 ± 0.16 b	330.75 ± 1.59 c	120.63± 0.98 c	87.25 ± 0.56 c
CD	0.47	7.34	2.75	1.45

* Mean of four replications

Table 2. Feeding potential of *C. zestrowi* on different instars of *P. marginatus* (Free choice condition)

Different Instars of *C. carnea*	Number of different instars of mealybug consumed* (mean ± SE)		
	I[st] instar nymph	II[nd] instar nymph	III[rd] instar nymph
1[st]	16.21 ± 0.40 [a]	7.00 ± 0.69 [a]	0.75 ± 0.12 [a]
2[nd]	23.04 ± 0.34 [b]	10.42 ± 0.75 [b]	3.75 ± 0.26 [b]
3[rd]	23.50 ± 0.48 [b]	11.58 ± 1.16 [c]	6.875 ± 0.22 [c]
CD	1.21	0.93	0.61

* Mean of four replications

23.04 of first instar mealybugs respectively were on par whereas, the first instar consumed minimum number of 16.21 first instar nymphs of *P. marginatus*. Higher number of second instar mealybug nymphs were consume by third instar larvae of *C. zestrowi* (11.58) followed by second instar (10.42) and first instar *C. zestrowi* (7.00) The third instar of *C. zestrowi* consumed significantly higher number of 6.88 third instar nymphs of mealybug whereas the second instar of predator consumed 3.75 third instar nymphs of *P. marginatus*. The first instar *C. zestrowi* consumed lowest number of 0.75 ± 0.69 third instar nymphs of mealybug. The higher response of the predator towards the first instar prey could be attributed to the absence of thin white waxy layer on the bodies of the first instar compared to second and third instar prey. Similar trend was also reported by Liu and Chen (2001) for *C. zestrowi* reared on *Lipaphis erysmi.*

Predation of *C. montrouzieri*

No choice condition -

The fourth instar grub of *C. montrouzieri* consumed significantly higher no. of 13.13 ovisacs, 337.50 first instar nymphs of *P. marginatus* followed by 218.00, 174.25 and 124.75 nymphs consumed by third, second and first instar grubs of *C. montrouzieri* respectively (Table 3). First instar grub of *C. montrouzieri* consumed minimum number of 67.00 second instar nymphs of *P. marginatus* whereas the fourth instar grub consumed maximum number of 209.25 nymphs. This was followed by the consumption of 169.25 and 97.00 second instar mealybug nymphs by third and second instar grub of *C. montrouzieri* respectively The fourth instar grub of *C. montrouzieri* consumed maximum number of 137.38 of third instar mealybug nymphs where as minimum consumption of 31.88 third instar mealybugs by first instar grub.The third instar grub of *C. montrouzieri* consumed maximum number of 83.25 third instar mealybug nymphs followed by minimum consumption of 54.13 third instar mealybug nymphs by second instar grub of *C. montrouzieri*. The highest feeding rate was observed in the fourth larval instar than other instars of *C. montrouzieri.*

Table 3. Feeding potential of C. montrouzieri on different instars of *P. marginatus* (No choice condition)

Different Instars of *C. montrouzieri*	Total number of different instars of mealybug consumed* (mean ± SE)			
	Ovisac	1st instar nymph	2nd instar nymph	3rd instar nymph
1st	4.38 ± 0.18 [a]	124.75 ± 0.94 [a]	67.00 ± 0.85 [a]	31.88 ± 0.77 [a]
2nd	7.13 ± 0.30 [b]	174.25 ± 1.06 [b]	97.00 ± 0.88 [b]	54.13 ± 1.23 [b]
3rd	9.63 ± 0.26 [c]	218.00 ± 1.98 [c]	169.25 ± 0.86 [c]	83.25 ± 1.13 [c]
4th	13.13 ± 0.40 [d]	337.50 ± 2.16 [d]	209.25 ± 0.94 [d]	137.38 ± 1.38 [d]
CD	1.04	4.72	2.59	3.32

* Mean of four replications

Free choice condition -

Significantly higher number of 84.46 first instar nymphs of mealybug was consumed by fourth instar grub of *C. montrouzieri* whereas first instar grub of *C. montrouzieri* consumed minimum of 24.50 first instar mealybug nymphs (Table 4). The third instar grub of *C. montrouzieri* consumed 60.17 first instar mealybug nymphs followed by second instar grub with 43.00 numbers of first instar mealybug nymphs. Maximum consumption of fourth instar *C. montrouzieri* was 52.58 second instar mealybug nymphs followed by third instar grub with 41.50 mealybug nymphs. Minimum number (14.88) of second instar mealybug nymphs consumed by first instar grub of *C. montrouzieri* whereas the second instar grub of *C. montrouzieri* consumed maximum of 29.96 second instar mealybug nymphs. The maximum third instar mealy bug nymphs (31.46) consumed by fourth instar grub of *C. montrouzieri*

Table 4. Feeding potential of C. montrouzieri on different instars of *P. marginatus* (Free choice condition)

Different Instars of *C. montrouzieri*	Number of different instars of mealybug consumed* (mean ± SE)		
	1st Instar nymph	2nd Instar nymph	3rd Instar nymph
1st	24.50 ± 0.47 [a]	14.88 ± 0.45 [a]	7.71 ± 0.32 [a]
2nd	43.00 ± 0.48 [b]	29.96 ± 0.63 [b]	14.17 ± 0.48 [b]
3rd	60.17 ± 1.12 [c]	41.50 ± 0.50 [c]	23.13 ± 0.40 [c]
4th	84.46 ± 0.48 [d]	52.58 ± 0.27 [d]	31.46 ± 0.66 [d]
CD	2.00	1.39	1.39

* Mean of four replications

whereas the minimum number of 7.71 consumed by first instar *C. montrouzieri* grub. The second and third instar grubs of C. *montrouzieri* consumed 14.17 and 23.13 third instar mealy bug respectively.

In the no choice test the total number of life stages viz., ovisacs, first, second and third instars of the mealy bug consumed during the three larval instars of *C. zestrowi* were 6.51, 646.13, 228.39 and 137.63 respectively, while that by the four instars of *C. montrouzieri* were 34.28, 854.50, 442.50 and 306.64 respectively. In the free choice test the total number of life stages viz., first, second and third instars of the mealy bug consumed during the three larval instars of *C. zestrowi* were 62.75, 21 and 11.35 respectively, while that by the four instars of *C. montrouzieri* were 212,116 and75.98 respectively. The results of tests reveal that these two predators have great potential to reduce the field population of *P. marginatus.*

ACKNOWLEDGEMENT

We thank Department of Agricultural Entomology, College of Agriculture, Vellayani, Thiruvananthapuram for providing basic infrastructural facilities.

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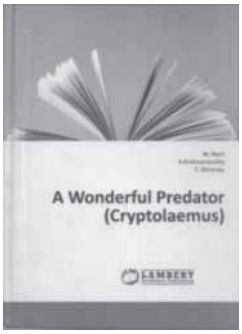
(Received 09-09-2014; accepted 31.10.2014)

Book Review



A WONDERFUL PREDATOR (*CRYPTOLAEMUS*)

M. Mani, A. Krishnamoorthy and C. Shivaraju
Publishers : LAP LAMBERT Academic Publishing
AV Akademikerverlag GmbH & Co. KG
Heinrich-Böcking-Str. 6-8,
66121, Saarbrücken, Germany
Year of Publication: 2013

The Australian ladybird beetle, *Cryptolaemus montrouzieri* Mulsant played an important role in the management of mealybugs and soft scales. This book is an exhaustive collection of information on *Cryptolaemus*. Initial chapters devoted to the systematics of *Cryptolaemus* include illustrated keys to species and subspecies of the genus. A comprehensive list of countries where *C. montrouzieiri* and *C. affinis* were introduced for biological control of mealybugs and soft scales is provided. Chapters cover host range, biology, life table and feeding potential on various host insects. Mass production techniques and information on storage supported with photographs are given in detail. Elaborate information on the role of ants on the efficiency of *C. montrouzieri*, non-target effects of insecticides on the life stages of *C. montrouzieri*, pheromones/ kairomones and interaction with other mealybug parasitoids are some of the other aspects covered. Extensive information on the colonization of *C. montrouzieri* against the scales and mealybugs is provided. Crop wise information on the management of mealybugs with *C. montrouzieri* along with factors contributing to the success or failure are given for the benefit of researchers, extension personnel and farmers. The references covering the period from 1815 to 2011 are provided.

While complementing the authors for the complete coverage of information and their stupendous task on *Cryptolaemus*, I consider this book an invaluable treasure for libraries, policy makers, students and researchers in the field of pest management.

Dr. M. S. Palaniswami
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Former Head, Crop Protection Division & Acting Director
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OBITUARY

Members of the Association for Advancement of Entomology places on record their deep sense of sorrow in the early demise of one of its eminent members, Dr. T.C. Narendran on 31-12-2013, indeed a great lose to AAE and to the field of Entomology. He was intimately associated with the activities of the association right from the time of its inception in 1975.The immense contributions made by him to bring the unit formed at the University of Kerala as a prominent scientific organisation of India with the membership of the students, teachers and researchers from many institutions in India and abroad are noteworthy.

Dr. Narendran was born on 24-2-1944 in Trichur district of Kerala, India. After completing his school education in his home town Trichur, he joined St. Johns College, Agra, Uttar Pradesh and graduated in Zoology with distinction with specialisation in Entomology. He had his post graduate degree from Calicut University in Kerala and he acquired Ph D. in 1975.Then he joined as a Lecturer in the Zoology department of the University. Passing through the different teaching cadres of the University he became Professor of Zoology in1988 and retired from service in 2004 as HEAD of the department.

His enthusiasm and sustained hard work done in the University for the past four decades earned him the reputation of an outstanding insect taxonomist in India and abroad. He had initiated and successfully completed several research programmes in the field of Insect taxonomy, particularly of parasitic Hymenoptera. His intimate association with several renowned taxonomists working in well known institutions of the world like the Natural History Museum, London, U.S. National Museum of Natural History, Washington D.C. enabled Dr. Narendran to take up several collaborative research programmes in widely different ecosystems. He had guided the research projects of 26 Ph.D. students and an equal number of students in M. Phil programme working in Calicut University, India. The results obtained from the above mentioned programmes have been covered in about 350 research papers published in internationally reputed journals. He has the publication of about a dozen books to his credit, some of them being monographs covering very extensive and pioneer work on parasitic Hymenoptera. He was an authoritative taxonomist of parasitic Hymenoptera and many researchers benefited from his liberal help and advice. This resume is reflecting only a portion of the extensive and valuable contributions of Dr. Narendran to the field of insect taxonomy and other related branches.

We record here our heartfelt condolences to the bereaved family and pray his soul to rest in peace.

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ACKNOWLEDGEMENTS

The Editorial Board of ENTOMON is grateful to the following reviewers for their invaluable comments and suggestions in evaluating the research articles published in the ENTOMON volume 38, issues 1 to 4.

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1.	Place of publication	:	Trivandrum
2.	Periodicity of publication		Quarterly
3.	Printer's name, nationality and address	:	Dr K D Prathapan, Indian, Secretary, Association for Advancement of Entomology, Department of Entomology, College of Agriculture, Kerala Agricultural University, Vellayani PO, Thiruvananthapuram 695522, Kerala, India
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